Kaeser Audits | Control Storage | Retro-commissioning

December 2011

COMPRESSED AIR BEST PRACTICES®

ATLAS COPCO SUSTAINABILITY

Keeping your production on track

Hi, I'm Daniel and I've been a service technician working with Atlas Copco products for over 26 years. I've seen technology race ahead over that time, but the one thing always setting the pace is our commitment to keep your productivity on track.

The key behind Atlas Copco's service offering is that it's fully customizable, with a selection of plans and programs that put **you** in the driver's seat. We understand how important compressed air is within your workplace and keeping your production fine tuned is our number one priority. Looking after your processes and applications is part of every Atlas Copco employee's mission and this goes far beyond the compressor room. Inspecting your piping system for leaks, assessing pressure drops, and checking condensate drains is all in a day's work for our service teams.

Our driving force is to continue to bring sustainable productivity through safer, cleaner, more energy-efficient and cost-effective compressed air technology. Simply log onto **www.atlascopco.us/danielusa** or call **866-688-9611** to learn more about us, our products, and how we have earned and will continue to earn our reputation.

Sustainable Productivity

Atlas Copco

HITACHI COMPRESSOR CENTENNIAL ANNIVERSARY 2011

Celebrating 100 Years of Compressed Air Technology

1910 1950 1970 1980 1990 2000 2011

1911

2011

•1910: First product was a 5 HP electric motor, Hitachi was founded

•1911: 75kW Reciprocating - First Compressor in Japan

•1946: First Bebicon

•1954: Oil Free 22kW Reciprocating

•1967: Oil Free Bebicon

•1968: First Oil Free Rotary Screw DS Series

•1969: First Vortex Blower

•1976: Oil Injected Packaged Rotary Screw Series

•1977: Smallest 5.5kW Oil Injected Rotary Screw

•1980: First DSP Series Oil Free Rotary screw

•1981: Vortex Blower "E" Series

•1982: World's Smallest Single Stage Oil Free Rotary

•1986: World's Smallest Air Cooled Oil Free Rotary

•1985: World's First Oil Injected Scroll Bebicon

•1992: Vortex Blower "G" Series

•1995: Oil Free Scroll SRL Series

•2002: New Generation Oil Injected HISCREW2000 Series

2009:• New Oil Free Scroll SRL Series Multiplex

•2000: World's First Variable Speed Drive Oil Free Rotary

•1999: New Generation Oil Free Rotary Screw DSP Series

•2001: Package Scroll Bebicon

•2005: New Oil Free Scroll SRL Series

Leading Innovation over the last 100 years, Hitachi is proud to recognize the past and present milestones of air technology. It is with this foundation that we continue our growth for the next 100 years. Please join us in our centennial celebration as we strive to provide the most reliable, environment friendly and energy conscious products.

Hitachi Oil-Less Scroll SRL Series Compressors

Hitachi Oil-Free Screw DSP Series Compressors

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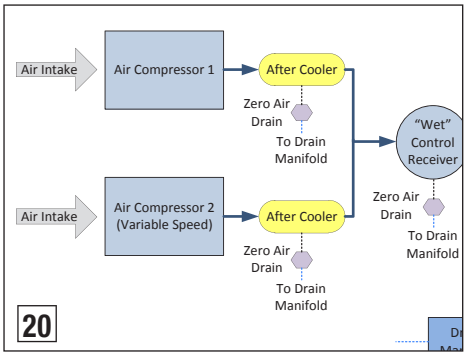
SUSTAINABLE MANUFACTURING FEATURES



COLUMNS

IS IT WORTH THE RISK?

Using anything other than Sullair replacement parts is like forcing a square peg into a round hole.

Sullair compressed air systems consist of highly engineered components, carefully matched for capacity and pressure and are designed for total system integration to achieve maximum performance and energy efficiency.

Maintaining the system

The dependability of a Sullair system relies on proper maintenance and quality parts. In fact, all Sullair service parts are designed for Sullair equipment and are built to exacting standards.

Sullair components must be routinely inspected and maintained to ensure that you'll always get the productivity your Sullair system was designed to deliver — at the lowest total life-cycle cost.

Lubricant technology leadership

Sullair pioneered the lubricated rotary screw compressor and today leads in the development of long-life and biodegradable lubricants that eliminate environmental pollution, improve economics, and maximize performance.

Sullair's name – inside and out

When replacement parts are needed, use only those from Sullair. Why? Because they are good enough to earn the Sullair name. ***Remember, installing anything other than a Sullair part in your compressed air system is like forcing a square peg into a round hole. Is it worth the risk?***

SULLAIR®

Always air. Always there.™

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FROM THE EDITOR

Compressor Controls

Air compressor controls play a key role in determining how much energy (kW) our installed air compressors consume. If you don't have a clear understanding of what type of controls your air compressors are using – and why – then you probably have an opportunity to save energy. It is critical to remember that a factory, without the appropriate compressor controls, could reduce their compressed air use by 20% and see only 5% savings.

Measuring and managing the Key Performance Indicator (KPI) of kW/100 cfm is a focal point of Neil Mehltretter's article, "Comprehensive Compressed Air Audits – The 5-Step Process." End users receive, from this article, a well-organized blueprint on how to conduct a compressed air audit on their own installation. How much kW does it take your plant to produce 100 cfm of compressed air flow? What will the new kW/100 KPI be at your facility after reducing demand? Kaeser Compressors' Mr. Mehltretter correctly points out that you can't assume a linear relationship between flow and kW reduction.

Ron Nordby, from John Henry Foster, provides us with an excellent article on control storage. Saying that control storage has become application specific, the article reviews the four basic types of rotary screw compressor controls; Modulation Control, Load/No Load Control, Variable Displacement, and Variable Speed Drive. Mr. Nordby then provides guidance on where and when control (also known as "wet") storage should be used according to the types of controls deployed by the installed rotary screw air compressors.

Atlas Copco has set the bar pretty high for itself with it's commitment to Sustainability. I wrote the article, "Substance in Sustainability at Atlas Copco" because first I appreciate the fact that they report their own energy use according to the Global Reporting Index. GRI provides sustainability reporting guidelines that encourage transparency and accuracy. Secondly, Atlas Copco has introduced several new products focused on achieving their goal to reduce the energy consumption of their customers by 20% by the year 2020. Easy-to-install and use, the new standardized heat recovery packages are an excellent example. I observe a lot of companies marketing sustainability – my observation is that Atlas Copco has invested in the areas of substance in sustainability.

Chris Beals, from Air System Management and on behalf of the Compressed Air Challenge®, provides a great list of "tales" from his notebook as a veteran compressed air auditor. This may seem like a list of "tall tales" – but it's not and we continue to find these kinds of situations every day. The good news is that these stories demonstrate the tremendous opportunities to conserve energy that are present in most compressed air installations.

Retro-commission incentives focus on maximizing the performance of existing systems. Nathaniel Altfeather, from Wisconsin's Focus on Energy, shares the results of their pilot program introduced this past year. The results were 2.3 million kWh in annual energy savings at an incentive cost of less than $0.03/kWh for the first year's savings. I hope this article will spark interest in the creation of more incentive programs like this one.

We hope you enjoy this edition. Thank you for your support and for investing in *Compressed Air Best Practices®*. BP

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"It is critical to remember that factories, without the appropriate compressor controls, cannot assume a linear relationship between flow and energy reduction."

— Neil Mehltretter, Kaeser Compressors

SUSTAINABLE MANUFACTURING NEWS

The 2011 Federal Energy and Water Management Award Winners

SOURCED FROM THE WEB

The Federal Energy and Water Management Awards recognize individuals, groups, and agencies for their outstanding contributions in the areas of energy efficiency, water conservation, and the use of advanced and renewable energy technologies at federal facilities. Winners of the 2011 Federal Energy and Water Management Awards include:

The Vandenberg Air Force Base energy conservation program uses a combination of tailored management approaches, energy efficiency projects, and aggressive energy awareness and training efforts to achieve results. Vandenberg went above and beyond Federal metering requirements by installing meters on substation circuits to identify "ghost loads." The system uses a combination of base wide area network (WAN), wireless transceivers, and fiber optics to communicate with more than 400 advanced electric, gas, and water meters across 6.6 million square feet of space. Vandenberg's tireless efforts led to a local area network (LAN)-connected energy management control system that, when combined with the automatic meter reading, will allow the base to participate in aggressive demand response programs. Vandenberg is also leading the Air Force's LED streetlight initiative, installing nearly 10,000 fixtures that save about $1 million annually. These efforts, along with building retrofits to lighting, motors, frequency drives, and controls, reduced energy intensity by 145 billion Btu in FY 2010, a 4.4% reduction

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from the prior year and 14% over three years. This equates to more than $3 million in annual energy savings and more than 166 thousand metric tons of avoided greenhouse gas emissions.

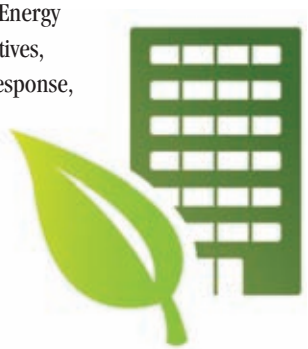
The Air Combat Command (ACC) team implemented a broad strategy to decrease energy demand while increasing its supply. Using the power purchase agreement (PPA) process developed for Nellis Air Force Base (AFB) and subsequently adopted as the Air Force standard, the team installed a 14.5 megawatt photovoltaic (PV) array at Davis Monthan AFB in FY 2010. These two projects generate 63 million kilowatt-hours, more than 25% of the entire Air Force renewable energy goal. ACC also developed an initiative to reuse excess solar panel equipment, installing small PV arrays at 14 other ACC bases. Looking to the future, ACC developed partnerships with two Department of Energy national laboratories in FY 2010 to assess renewable energy opportunities at every ACC base and explore developing 10 to 20 megawatts of geothermal resources at Mountain Home AFB. Through its audit and capital investment programs, ACC also awarded 67 energy conservation projects valued at $44 million in FY 2010 that saved more than 793 billion Btu. These and other projects saved a total of $4.4 million in energy costs and 353,240 metric tons of carbon dioxide.

In FY 2010, **Headquarters Air Mobility Command (AMC)** and the AMC Aviation Fuel Efficiency Office (FEO) successfully led a Mobility Air Forces (MAF) energy conservation effort resulting in unprecedented savings. MAF is the largest single user of aviation fuel in the Air Force, accounting for 62% of Air Force and 39% of Department of Defense aviation fuel consumption in FY 2010. The team worked to adapt strategies and management practices for the entire fleet of MAF aircraft, pursing conservation measures in anticipation of future missions that will place increasing demand on aviation fuel energy resources. To meet a goal of 10% fuel use reduction by 2015, the AMC instituted policy changes and innovative data collection methods across the full spectrum of MAF operations. In FY 2010, notable advances were achieved in aircraft performance, including increase of delivered cargo on combat flight missions, which reduced overall aircraft flight hour consumption rates. These strategies saved almost 48 million gallons of jet fuel and $131 million in FY 2010, and reduced carbon dioxide emissions by 515,335 metric tons annually.

The Aviation Energy Efficiency Program at the Pennsylvania Air National Guard's 171st Air Refueling Wing is regarded as the benchmark aviation efficiency program in the Air National Guard (ANG) and the Air Mobility Command (AMC). Through a comprehensive management system, the base was able to leverage its investment in human capital into significant aviation fuel savings. The program looked critically at aircrew practices, mission and training validation, optimized scheduling, and aircraft utilization. By seeking out fuel-efficient training opportunities during long-range planning and mission development, the base reduced its average training flight duration by 14% in FY 2010 from FY 2006, reducing fuel used in gallons per hour by 10%. The combined effect resulted in a 22% reduction in gallons of fuel consumed on a typical flight, saving 1.5 million gallons in FY 2010. In addition, these efficiencies resulted in a 9.2% reduction in greenhouse gas emissions of more than 1,100 metric tons of carbon dioxide equivalent per year. The program provided data collection tools, initiatives, and training programs to numerous Mobility Air Force wings to help them achieve similar success.

The Defense Logistics Agency Installation Support at Columbus energy management team (DS-FC) cultivated comprehensive strategies that translate into real policy and infrastructure change to tailor energy saving concepts to the specific needs of its customers. The team also established an excellent climate of internal energy awareness and conservation by implementing efficiency guidelines into daily activities and providing easy and effective ways for employees to contribute. The program cornerstones include installation of energy-efficient equipment, implementation of aggressive energy conservation technologies like computerized HVAC scheduling and free cooling systems, policies ordering the shutdown of lights and HVAC equipment when not in use, and energy education programs involving base employees. As a result of its multi-faceted program, in FY 2010 DS-FC reduced energy consumption by a record 7%, water consumption by 6.9%, and vehicle fuel use by 29% all from the prior year, for combined cost savings of almost $347,000. These efforts will reduce equivalent carbon dioxide emissions by more than 39,000 metric tons annually.

The Defense Logistics Agency (DLA)-Energy team helped overcome obstacles to Federal agency participation in demand response programs by instituting a "master agreements" program in FY 2009 allowing Department of Defense sites to contract with independent curtailment service providers (CSPs). Since most Federal sites are unable to accept checks, DLA-Energy also negotiated with the site electric utilities to have proceeds assigned directly from the CSPs to facility electric accounts. Energy management initiatives, such as demand response, do not directly save substantial electricity, but act to conserve our limited fiscal



resources and free up energy budget dollars to invest in other energy management projects. The creation of this ready mechanism to participate in demand response programs resulted in unexpectedly high Federal participation and savings. Within two years, 45 agreements were signed representing almost 170 megawatts of enrolled curtailment capacity. In FY 2010 alone, almost $4.7 million was saved through commitments to reduce electric load through short-term load reduction or the use of emergency generators. Life-cycle cost savings are estimated at more than $81.6 million.

Marine Corps Air Station (MCAS) Beaufort is recognized for its top-down commitment to energy, water, and fossil fuel conservation reflected by the command policies, outstanding leadership, and adequate resource allocation encouraging strong program performance and an energy efficiency culture. In FY 2010, the base completed phase III of an energy savings performance contract (ESPC) focusing on initiatives to improve building efficiency and expand installation of geothermal heat pumps and solar hot water heating. The renewable energy projects alone provide more than 4 billion Btu in annual thermal and electrical generation, representing 2.4% of base energy consumption. Overall, MCAS Beaufort's program reduced energy consumption by more than 10 billion Btu in FY 2010, nearly 23% from the FY 2003 baseline and more than 6.5% from FY 2009. Savings of 5.5 million gallons of water represent a 39.5% reduction in water intensity from the FY 2007 baseline and 7.7% from FY 2009. This equates to savings of more than $136,000 in energy and water costs in FY 2010 and avoidance of more than 23,000 metric tons of carbon dioxide emissions.

The U.S. Department of Energy's Bonneville Power Administration (BPA) Energy Smart Federal Partnership (ESFP) helps identify and fund energy and water efficiency projects for the Federal Powered Irrigation Districts (ID) in Washington, Oregon,

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and Idaho. The IDs are not Federal entities, but receive reserve water and power at very low rates through an agreement with the Bureau of Reclamation (BOR). ESFP worked with the BOR to contract directly with the IDs to access this untapped energy efficiency market. Through master agreement awards, 10 ESFP provided technical support and financial incentives to complete large-scale canal improvement projects at five IDs in the Columbia River Basin in FY 2010. Canal lining projects and installation of variable frequency drives helped save an estimated 16 billion Btu of electrical energy and more than 2 billion gallons of water annually from reduced pumping. These projects result in more efficient use of hydropower, reducing the region's reliance on fossil fuels.

Fort Drum Mountain Community Homes (FDMCH) is a partnership created between the Department of the Army and Acts Lend Lease. The partnership is through the Military Housing Privatization Initiative, designed to provide privatized development of military family housing and asset, property, and maintenance management for the military families stationed at Fort Drum. FDMCH utilized the New York State Research and Development Authority's ENERGY STAR® Certification program to complete construction of 917 new energy efficient and environmentally sound homes in FY 2010. The FDMCH project is the largest ENERGY STAR development in New York state history. The homes include greater insulation; energy-efficient windows, equipment, lighting, and appliances; and water conserving low-flow fixtures. Operations, construction, and residential services incorporated recycling, user education, and a solid maintenance program to ensure continued energy savings. The homes will save approximately 32 billion Btu and more than $568,000 in gas and electricity costs annually over comparable leased housing.

In FY 2010, **Marine Corps Air Ground Combat Center (MCAGC)** employed several strategies to meet and exceed Federally-mandated goals. Most notable, MCAGCC achieved 9.2% in renewable energy production through the implementation of photovoltaic systems totaling 2.6 megawatts (MW), utilizing a power purchase agreement to install 1.5 MW. Together, the systems are estimated to save about $350,000 per year. MCAGCC expects to have more than 10 MW installed by the end of FY 2012 toward achieving a net zero installation. MCAGCC also completed a project in FY 2010 exploring development of a closed loop geothermal system. These and other measures, including chilled water conversion and energy management control systems upgrades, contributed to FY 2010 savings of more than 56 billion Btu and 448 million gallons of water, equating to reductions of about 15% and 62% respectively from FY 2009. MCAGCC efforts saved more than $1 million in costs and prevented greenhouse gas emissions equaling more than 1,900 metric tons of carbon dioxide.

Puget Sound Naval Shipyard and Intermediate Maintenance Facility (PSNS & IMF) made particularly effective use of an often underutilized and low cost solution to saving energy. In FY 2010, the team achieved continuous commissioning of buildings through the assignment of a resource efficiency manager. Savings were realized predominantly through rescheduling of air handling units, exhaust fans, and heating coils for single shift or daytime operation versus continuous 24/7 operation. Additionally in FY 2010 a systematic steam, water, and air waste reduction program was implemented to detect and repair leaks. With an investment just over $303,000, these projects avoided more than $750,000 in energy costs and saved more than 70 billion Btu and 11.5 million gallons of water as compared to FY 2009. The efforts will also reduce carbon dioxide emissions by almost 3,000 metric tons annually. Also in FY 2010, PSNS & IMF purchased more than 9,600 megawatt-hours of wind power from Bonneville Power Administration (BPA) at no cost using available credits available under BPA's Conservation Rate Credit program.

Naval Base Point Loma (NBPL) represents a model of efficient teamwork and an organizational culture committed to driving a future of greater energy independence. To sustain the program's momentum, NBPL completed a wide range of photovoltaic (PV), solar thermal, energy and water efficiency, and low-cost/no-cost energy measures in FY 2010 that will save more than 11 billion Btu and 23 million gallons of water annually. Five new PV projects generate 529 megawatt-hours of renewable electricity per year, and a new solar pool heating system provides 350 million Btu of thermal energy, meeting 1.6% of the base's electricity requirements. Expansion of effective irrigation controls and practices reduce potable water consumption by 20% with no impact on mission, health, safety, quality of life, or base appearance. These and other projects completed in FY 2010 help the base achieve a reduction in energy intensity of more than 32% below its energy baseline and more than 36% below its water baseline. NBPL's program is a key part of the Navy Region Southwest energy program, which emphasizes close communication and sharing of information on programs, projects, emerging technologies, and lessons learned.

Every aspect of design and construction of the 5,879 square-foot visitor center at Assabet River National Wildlife Refuge exemplifies sustainability. The building includes passive solar architecture, a cool roof, daylighting, low-e glazed windows,

energy-efficient fluorescent and LED lighting, occupancy sensors, a 6.3-kilowatt grid-tied solar photovoltaic array, and a 12.5-ton ground source heat pump, all resulting in energy performance 30% better than an average building. The 19 megawatt-hours of renewable power generated offsets 13.1 metric tons of greenhouse gas emissions annually. Construction materials were recycled, and low-VOC emitting carpets, paints, and adhesives provide a healthy indoor work environment. Low flow plumbing fixtures and waterless urinals conserve 3,000 gallons of water per year. Outside, use of native plants, a "no mow" lawn, stormwater containment, and porous pavement help further reduce building water use to more than 20% below current standards. The knowledge gained by this project will be shared and applied to 66 other field stations, and will help the Fish and Wildlife Service move toward net-zero buildings for every project.

The U.S. Fish and Wildlife Service's Mountain-Prairie Region completed the region's first hybrid solar photovoltaic (PV)/wind energy system at Benton Lake National Wildlife Refuge in FY 2010. The grid-tied system includes 15.4 kilowatts of pole-mounted single-axis adjustable solar PV panels and a 10 kilowatt horizontal axis wind turbine. The integrated system accomplished a 93% decrease in purchased electricity consumption for the headquarters building and a 33% reduction in energy intensity from the field station's FY 2003 baseline. This equates to a cost savings of approximately $4,000 per year, an energy savings of 121 million Btu, and a reduction in greenhouse gases of 25 metric tons annually. Already super-insulated and sustainably designed, the headquarters facility also completed a lighting retrofit in FY 2010 to install T-8 fluorescent lights and electronic ballasts, occupancy sensors, and LED exit lights. This project serves as a model illustrating the feasibility of renewable hybrid solar PV/wind energy systems and educating other Fish and Wildlife Service facilities about this technology.

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The 9,000 square foot **San Francisco Bay National Wildlife Refuge Headquarters Complex** was renovated in FY 2010, incorporating sustainable design measures that reduced energy consumption by 52%. Energy conserving features include double-glazed, light-bronze tinted, low-e windows and doors with innovative thermal-break frames, expansive spray foam wall and ceiling insulation, LED and T-8 fluorescent lighting and electronic ballasts, occupancy sensors, daylighting, and ENERGY STAR appliances. The propane-fired boiler was replaced with a 6-ton ductless air-source building heating, ventilation, and air conditioning system with heat recovery of the exhaust air. A solar-thermal collector with an interior heat reservoir provides 100% of the domestic hot water, and low-water-use plumbing fixtures save 5,000 gallons per year. The project saved more than 350 million Btu in FY 2010 and more than $34,000 in energy costs. The complex has become a showcase facility, ushering in more than 60,000 visitors each year to enjoy the benefits of this green building.

In FY 2010, the **U.S. Coast Guard** used a power purchase agreement (PPA) to install an 875 kilowatt solar photovoltaic array at Training Center Petaluma. This innovative funding vehicle allows the Coast Guard to purchase renewable energy at a contracted rate for 25 years with no upfront development costs and no responsibility for system operation and maintenance. First conceived in FY 2006, the Coast Guard team worked through several legal and contract challenges before identifying potential solutions and issuing a project solicitation in FY 2008. More than 5,200 solar panels now cover four acres and are expected to produce between 1.5 and 1.7 million kilowatt-hours annually to handle 60% of the site's electric demand. The project is the largest ground mounted PV installation in the Coast Guard, as well as the first successful PPA in the Department of Homeland Security. The Coast Guard anticipates saving $1.6 million in energy costs over the life of the PPA while preventing more than 18,000 metric tons of carbon dioxide equivalent emissions from entering the atmosphere.

The Engineering Service Section at the West Texas Veterans Affairs (VA) Medical Center completed a renewable energy project in June 2010 for solar photovoltaic (PV) covered parking. This innovative PV design, a more sustainable alternative to both roof and ground-mounted PV systems, is significant as it is the first project of its kind constructed at a VA medical center. The system is rated at 180 kilowatts and generates approximately 255 megawatt-hours of energy annually. It is also easily expandable and virtually maintenance free. Depending on the time of year, the system subsidizes the medical center's commercial power between 5% and 10%. The project will save a minimum of $30,000 and reduce greenhouse gas emissions by about 176 metric tons of carbon dioxide per year. The PV system's high reliability and solid performance has already led the way for PV covered parking at 25 other VA medical centers and the Kirtland Air Force Base outpatient clinic.

In FY 2010, the **Department of Veterans Affairs Massachusetts National Cemetery, Air Force, Environmental Protection Agency, and Massachusetts Department of Environmental Protection** partnered on a project to use 100% reclaimed water to irrigate the cemetery grounds with water from the adjacent Otis Air National Guard Base contaminated groundwater filtration system. The filtration system uses six recovery wells to remove chlorinated solvent contaminated groundwater, filters it through activated carbon, and then returns it to the aquifer. Use of the reclaimed water eliminated the need for 30 million gallons of groundwater withdrawal from the aquifer annually, resulting in a 10% increase in public water availability. Total savings will be approximately 1.8 billion gallons of water over the life of the system. This project far exceeds Executive Order 13514 potable water reduction requirements of 26% 10 years ahead of schedule and is a unique example of cooperation between three Federal agencies and one state agency to reduce potable water use.

The Department of Veterans Affairs Fort Bliss National Cemetery previously relied on the heavily over-utilized Hueco Bolson Aquifer for irrigation water. The existing water sources were often insufficient in summer, resulting in a poor landscape appearance. The project, aiming to reduce potable water use and find irrigation alternatives in the desert climate, replaced 60 acres of irrigated turf with xeriscaped areas of low water use turf, drought-resistant ground covers and trees, and water conserving mulch, resulting in one of the largest xeriscaping conversion projects on record. The new and improved irrigation system also uses a highly efficient drip/bubbler irrigation system, watering only at the location of the plant. The project reduced water use at the cemetery by 90%, saving 56 million gallons of water per year, and reduced irrigation energy use by 47%. The project saved more than $400,000 in water, energy, and maintenance costs in FY 2010. Five cemeteries located in arid regions of New Mexico and California are currently being evaluated for xeriscaping based on the project's success, and two new cemeteries were designed using features of the Fort Bliss project.

Source: http://energy.gov

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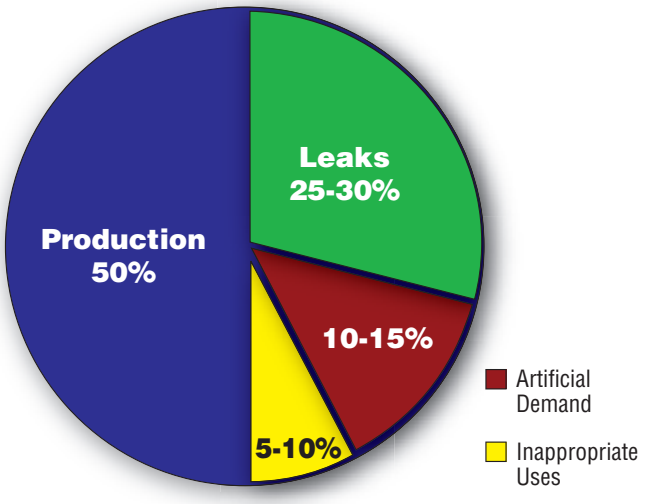
THE SYSTEM ASSESSMENT

Comprehensive Compressed Air Audits: The 5-Step Process

BY NEIL MEHLTRETTER, SYSTEM ENGINEERING SUPERVISOR, KAESER COMPRESSORS

The U.S. Department of Energy estimates that air compressors use as much as 10% of all electricity generated in the United States. Further, the DOE calculates that as much as 50% of this energy is wasted. Compressed air leaks alone account for 25-30% of compressed air use.

Consequently, many industrial companies are identifying ways to lower their compressed air system energy consumption. One of the most popular methods to do so is a comprehensive compressed air audit, or "air demand analysis." The objective of this paper is to define the five steps required in a compressed air audit. We will use a real-world example with system information from a magnetic materials manufacturer to clearly illustrate each step. In the following case, the user achieved a 42% reduction in annual energy costs.



Step 1: Conduct a Site Survey

It is important to list and understand all the equipment in a compressed air system before installing any measurement devices so that 1) the devices are properly placed, and 2) system dynamics are properly understood. The person responsible for collecting information should note: environmental conditions, physical layout, details on all air system components including clean air treatment, piping, storage and controls. Processes at the facility should also be documented. Many auditors will have a questionnaire which they will complete to compile the details into one document.

Case: This facility had two compressor rooms using rotary screw air compressors from three different manufacturers. They also had a mix of refrigerated air dryers, receiver tanks and filters. The piping network was made up of 1.25, 1.5 and 2 inch lines.

Both Compressor #1 and #2 were operating in modulation control. Compressor #3 was also using modulation control but was offline during the testing period.

COMPRESSOR ROOM #1	
(1) Compressor #1, water-cooled screw compressor with modulating controls	rated 267 cfm at 125 psig
(1) 240 gallon storage receiver prior to air treatment	
(1) Refrigerated air dryer with one pre-filter and two after filters	

COMPRESSOR ROOM #2	
(1) Compressor #2, air-cooled screw compressor with modulating controls	rated 215 cfm at 125 psig
(1) Compressor #3, air-cooled screw compressor with modulating controls. *Note: Offline during testing period.*	rated 350 cfm at 125 psig
(1) Refrigerated dryer with pre and after filters	
(1) 240 gallon storage receiver after air treatment	

Step 2: Measure and Quantify kW/100 cfm

For many systems — power, flow, and pressure should be measured for a period of 10-days to obtain an accurate system snapshot (other data points such as pressure dew point [to determine air quality], vacuum, and temperature should be measured as needed based on system requirements). The measurement period should include nights, weekends or other downtime to identify non-productive demands. True power used by the air compressors is measured using kilowatt meters which would monitor amperage, voltage, and power factor. Data loggers should record data points on each air compressor every 0.5 seconds, and average the data over a preset recording interval such as 20-second resolution.

A suitable Key Performance Indicator (KPI) for all compressed air systems is specific power consumed (kW) per 100 cubic feet per minute (cfm) of compressed air used in the plant. This provides an idea of how efficient a compressed air system is — regardless of varying plant output levels. Recommended systems have a KPI below 21 kW/100 cfm.

Case: Flow on Compressor #2 was measured by installing a vacuum transducer at the inlet of the air compressor. A vacuum transducer could not be installed on Compressor #1, so a flow meter was installed at the discharge of this system prior to the distribution piping. Pressure sensors were installed in both compressor rooms as well.

The measured specific power KPI (kW/100 cfm) of the existing system was measured at almost 32 kW/100 cfm. Based upon this there was reason to suspect significant energy cost savings potential.

Step 3: Understand the System Dynamics

The system information collected should be thoroughly analyzed and areas of improvement should be identified. Multiple scenarios should be considered to lower the compressed air system's energy consumption, including an analysis of the major compressed air users within the facility to determine whether compressed air is the most efficient option for each application.

Case: The average compressed air supply was 240 cfm at the required plant pressure set point of 95 psig. The measured compressed air supply range was between 200 and 300 cfm.

Most often, both Compressors #1 and #2 were loaded to maintain plant pressure. The available compressor supply significantly exceeded the compressed air demand. Based on the measured flow profiles during the testing period, Compressor #1 was capable of meeting the average demand without assistance from Compressor #2, but was not capable of meeting the peak demand. As shown in Figure 1, the two units were running in modulation control, which partially opened or closed the compressor inlet valves -- creating vacuums at the inlets to match supply to demand. Due to the negative pressure at the inlet valves, the compression ratio was increased which increased the amount of power

THE SYSTEM ASSESSMENT

Comprehensive Compressed Air Audits: The 5-Step Process

required per cubic foot of air to meet the set point pressure. Though the two compressors were maintaining a steady operating pressure, they required extremely high power consumption at partial loads thus creating the very inefficient Specific Power KPI of 35 kW/ 100 cfm.

When Compressor #1 was either manually stopped, or when the unit experienced a failure, pressure in the facility dropped below the minimum required level of 95 psig. During these times the flow meter at Compressor #1 read an average of 50 cfm. This suggests that a significant portion of the air demand was air leakage. Figure 2 highlights one such day. This graphic also shows the significant pressure drop between the two compressor rooms when Compressor #1 was offline, between 10 psi and 15 psi. This suggests that the piping network (1.25, 1.5 and 2 inch) was insufficiently sized.

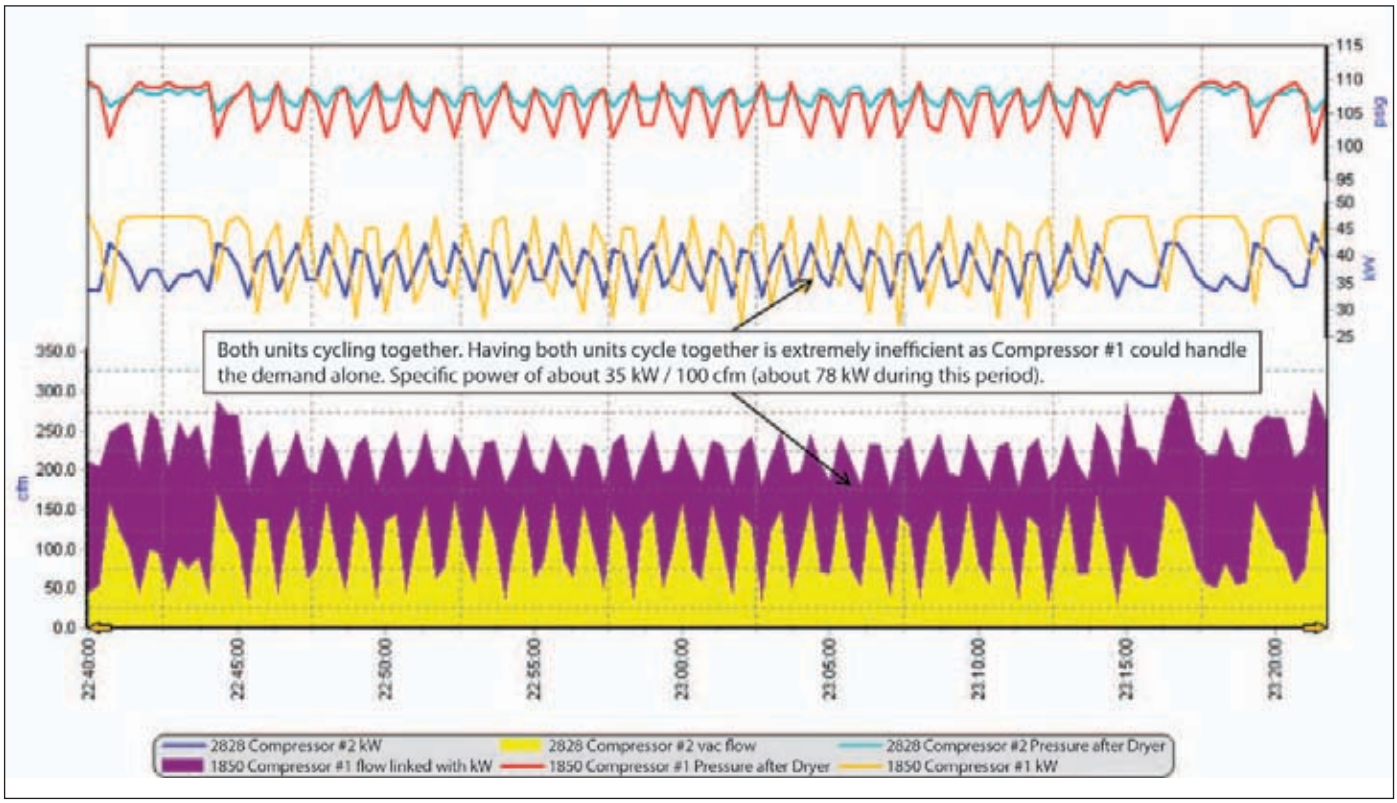
The air treatment equipment was working well and no issues were noted. The equipment was sized for worst-case ambient conditions which is a good practice.

Step 4: Implement a Recommendation to Improve kW/100 cfm

Without proper system control, the system's overall energy consumption may not be significantly lowered.

Many system assessments focus on reducing compressed air consumption by fixing compressed air leaks or through the elimination of "inappropriate uses" of compressed air. Using engineered air nozzles, for example, to replace perforated pipe for blow-off applications will reduce compressed air demand. Real energy savings, however, will ONLY be realized if the controls on the air compressors can capitalize on these gains and when appropriate this includes proper use of a variable frequency drive (VFD). The costs involved with adjusting compressor controls are almost never included in the ROI calculations.

Figure 1: Compressors #1 and #2 Running in Modulation Control



Many modulating air compressors will continue to consume the same amount of electricity (kW) within broad ranges of compressed air flows (cfm). Users cannot assume a linear relationship between compressed air use and power consumption.

Case: The following recommendations were accepted and implemented:

1. Installed a 55 kW VFD, air-cooled, rotary screw air compressor able to handle the full air load.
2. Removed Compressor #3, but retained Compressors #1 and #2 for back-up.
3. Reconfigured the piping in the facility to eliminate pressure losses and air leaks.
4. Increased storage with a 1040 gallon dry tank.

The piping was a critical component in the system's optimization. Creating a closed loop allowed for the proper system pressure downstream, but required less work of the compressor. With the 55 kW unit capable of providing 389 cfm at 100 psig and sized

Installing a 55 kW VFD would result in an estimated 13.54 kW savings per 100 cfm.

to operate in its most efficient range between 40-85% load, the new specific power KPI was estimated to be 18.6 kW/100 cfm. This KPI would meet the recommendation to be below 21 kW/100 cfm, and represented a significant improvement over the existing systems' specific power KPI of 32.14 kW/100 cfm.

THE SYSTEM ASSESSMENT

Comprehensive Compressed Air Audits: The 5-Step Process

Step 5: Verify Performance of kW/100 cfm

Utility rebate programs sometimes require energy savings be verified by an additional compressed air audit performed after the air system is optimized. In cases where utility rebates do not require such a degree of verification, facilities should still consider implementing some form of a post-optimization assessment. All systems can be enhanced — even systems designed using air audit data and that are newly installed. The additional assessment should verify the compressed air audit findings, as well as assist in identifying additional areas of improvement. Some system controllers actually track and store ongoing energy consumption data, so for many, a review with a master system controller provides enough information for internal evaluation and can be used to verify improvement metrics.

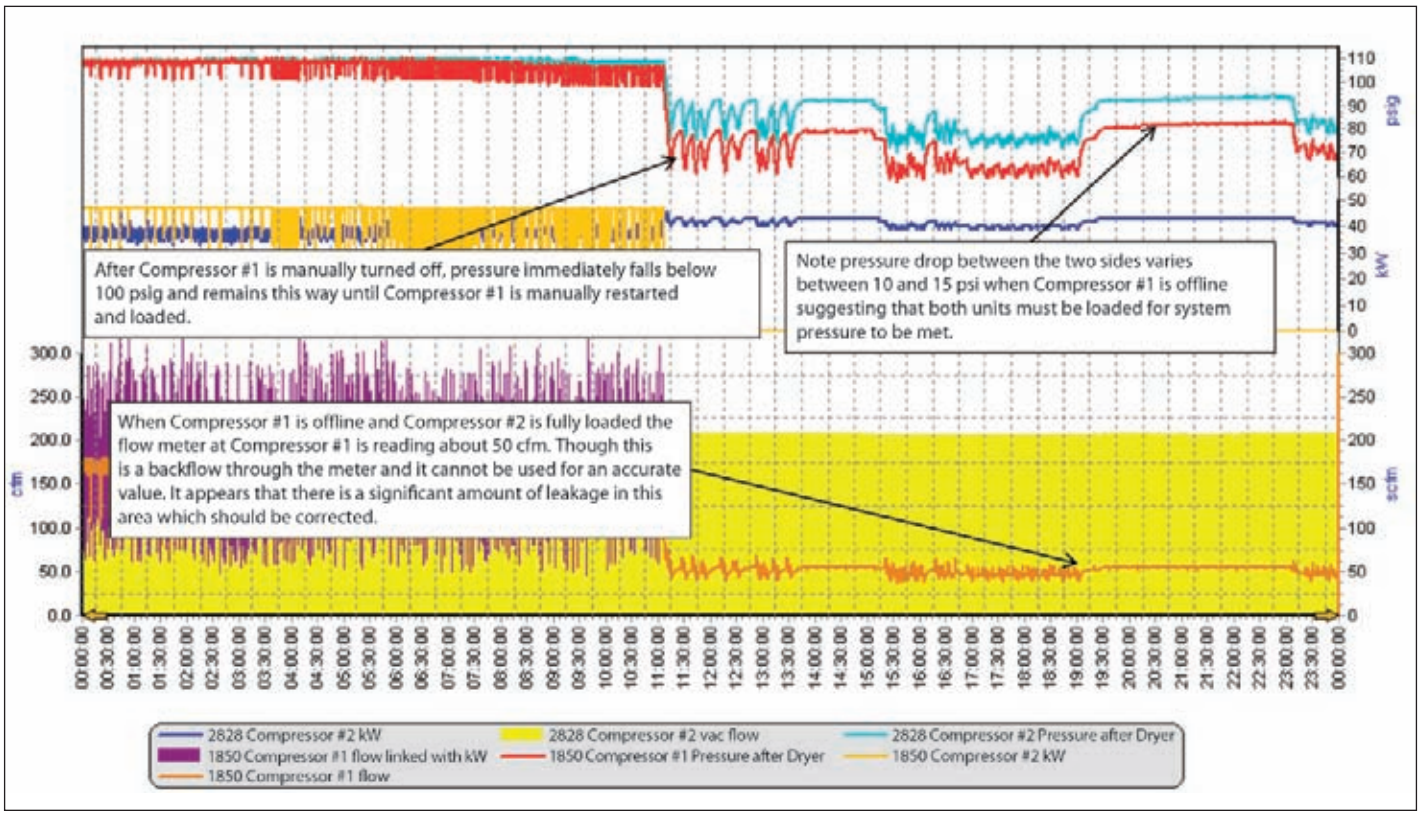
Case: A follow-up compressed air audit was performed for this manufacturer. The verification results showed that although the overall air demand in the factory had gone up (from 244 to 289 cfm), the 55 kW VFD efficiency was well within the target zone of 18.6 kW /100 cfm KPI. Average operating pressure had also been reduced by 3 psig. Eliminating the water-cooling requirement provided a bonus potential savings of $1,208 per year (based upon $0.20 per 1,000 gallons cost of cooling water). The annual energy savings were verified at $19,165 per year — a whopping 42% reduction in energy cost and slightly higher than what was estimated.

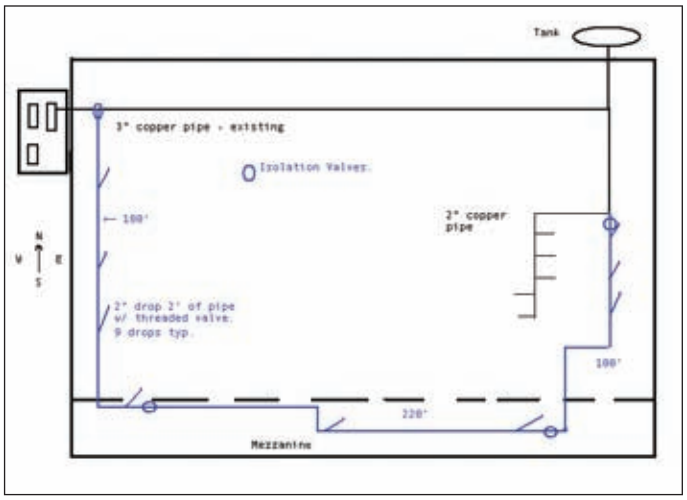
Conclusion

It is critical to focus on improving the specific KPI of kW/100 cfm. Compressed air users can ensure return on investments (based upon energy savings) on air system audits by working with firms who measure at least power, flow, and pressure over a period long enough to obtain an accurate system snapshot, often 10 days. Further, the data obtained from the audit must be thoroughly analyzed and recommendations should be made based on conservative estimates of power reduction.

When implementing an optimization plan, it is important to remember that without proper system control, the system's overall energy consumption may not be significantly lowered. In the case described, adding a VFD unit allowed the system to generate compressed air at the lowest acceptable pressure, thereby reducing energy consumption and cost. In many cases, a master system controller is the best solution as master controllers use compressors at their most efficient design point or turn them off.

Figure 2: Compressor #1 Offline





Without reconfiguring the compressed air piping (blue pipe in image), the facility may have not have met the energy savings required for the utility rebate.

DESCRIPTION	PROPOSAL ESTIMATE	VERIFICATION
Annual flow (cf/year)	128,010,406	130,600,422
Existing Energy Consumption	685,792 kWh/yr	699,668 kWh/yr
Proposed Energy Consumption	395,942 kWh/yr	404,822 kWh/yr
Annual Energy Savings	**289,850 kWh/yr**	**294,846 kWh/yr**
Energy Cost	0.065 $/kWh	0.065 $/kWh
Existing Energy Cost	$44,577 / yr	$45,478 / yr
Proposed Energy Cost	$25,736 / yr	$26, 313 / yr
Annual Energy Savings	**$18,840 / yr**	**$19,165 /yr**
Original System Specific Power KPI	32.14 kW/100 cfm	32.14 kW/100 cfm (This KPI is assumed based on the slightly higher flow profile.)
Specific Power KPI	**18.56 kW/100 cfm**	**18.60 kW/100 cfm**

Finally, users that complete a compressed air audit and optimize their systems will surely reduce energy consumption and see lower operating costs. However, even the best, newly optimized systems can always be further improved. Facilities should be advised that additional savings can be determined by completing a leak detection audit in conjunction with a full evaluation of the demand-side of the facility for appropriate use of compressed air. Facilities should determine which services are best suited for them (leak detection, supply-side compressed air audit, and/or demand-side compressed air audit), and develop a plan for how often those services should be performed. BP

For more information please contact Kaeser Compressors, tel: 877-586-2691, email: ada.us@kaeser.com, www.kaeser.com/ada

CONTROL (WET) STORAGE

A Misunderstood Concept

BY RON NORDBY, VICE PRESIDENT SALES AND MARKETING, JOHN HENRY FOSTER

When evaluating a compressed air system and the proper application of storage, one of the most misunderstood concepts is control storage. It is often referred to as wet, primary, or in some cases demand storage. However, the term control storage is more reflective of its main function - to maximize the effective operation of the compressor control. For the purpose of this article, I have limited the definition of control storage to any storage created between the air compressor discharge, and before any cleanup equipment i.e. filters and air dryers.

While one can argue that control storage shares some commonality of purpose with the more commonly applied demand (dry) storage (storage created after cleanup equipment and before demand regulation), it differs in the location of the storage and its functionality. It is not that unusual in compressed air system design to integrate both control and demand storage taking into account the primary function of both.

While control storage was originally an integral component of a reciprocating air compressor installation, this article will only briefly explore that application. The content of this article will focus instead on rotary screw installations since the rotary screw air compressor has essentially replaced the reciprocating as the compressor of choice in industrial applications. It should also be noted that in compressed air systems where reciprocating and rotary screw air compressors are operating together, control storage should always be utilized.

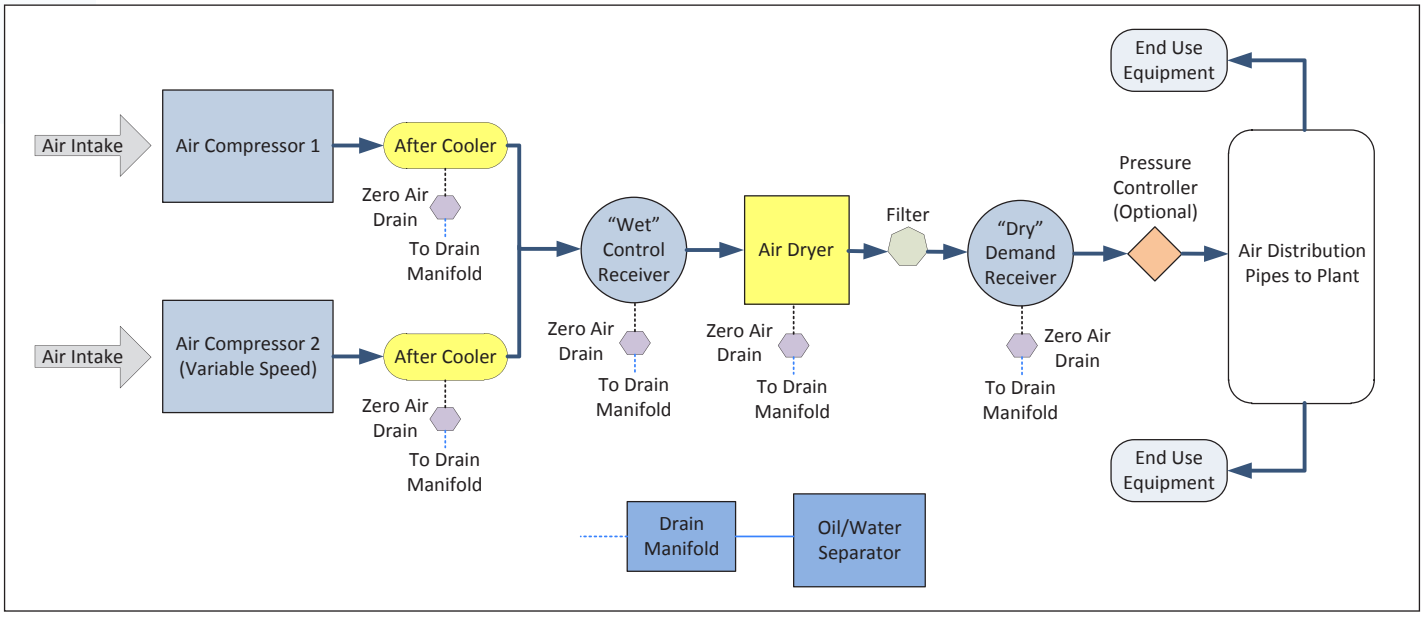


Diagram provided by CEA Technologies Inc. Compressed Air Energy Efficiency Reference Guide. John Henry Foster modified.

The reciprocating air compressor, up until the 1960's, was the air compressor of choice and utilized extensively in general industrial plants. Control storage was always an integral part of a reciprocating air compressor installation; whether it was a tank mount configuration for 25 hp or smaller units, or a stand-alone vertical or horizontal configuration for larger hp.

Three main reasons determined why control storage was always used in conjunction with reciprocating air compressors:

1. Reduce the pulsations from the compressor discharge
2. Provide condensate removal through condensation and settling
3. Eliminate short cycling of the compressor controls

Starting in the 1960's with the universal acceptance of rotary screw technology (both oil-flooded and oil-free), the reciprocating air compressor has virtually been replaced within the general industrial market. The demise of the market for reciprocating air compressors has led to a misunderstanding of when and how to apply control storage. This lack of understanding seems to have coincided with two major advantages inherent in rotary screw design – the elimination of pulsations at the compressor discharge and the development of alternative control schemes such as modulation, variable displacement and variable speed.

Over the last 30 years, there has been a perception that control storage is no longer required, as its function has been replaced by the flexibility of the modern compressor

"Control storage is a tool that can significantly improve the reliability and operation of an air compressor system, but needs to be properly evaluated."

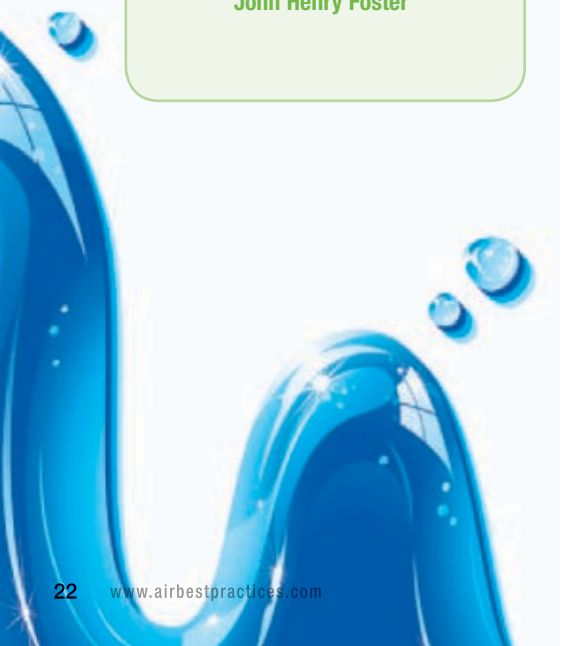
— Ron Nordby, Vice President, Sales and Marketing, John Henry Foster

CONTROL (WET) STORAGE — A MISUNDERSTOOD CONCEPT

"The role of control storage is more application specific than 30 years ago. The question you should be asking today...

Where should control storage be applied and is it a required component of an air compressor system regardless of control type?"

— Ron Nordby, Vice President, Sales and Marketing, John Henry Foster



controls. Therefore, the question becomes "Is control storage an outdated concept?" The answer is no, control storage is not an outdated concept; however its role has become more application specific. The discussion now becomes "Where should control storage be applied and is it a required component of an air compressor system regardless of control type?" While there is not a clear yes or no answer, there are a few general principles that can be applied when taking into account the four basic types of compressor controls offered on rotary screw air compressors:

1. Modulation Control
2. Load/No Load Control
3. Variable Displacement
4. Variable Speed Drive (VSD)

Modulation Control

Rotary screw compressors with modulation control do not necessarily require control storage. While modulation control is not the most efficient control at partial compressor loads, its smooth control reaction to changes in compressor load minimize the need for control storage. The only exception would be very low demand loads, where the compressor would operate for a sustained period of time outside of the modulation range. It should be noted that in reality this is a very uncommon occurrence.

Load/No Load (On-Line/ Off-Line) Control

Load/no load (also referred to as on-line/ off-line) control, which is predominant in oil-free and some manufacturers of oil-flooded rotary screws, does require control storage. Without the proper amount to control storage, the short cycling of the controls will occur causing premature wear and failure of the compressor control system. This is exhibited in rapid loading and unloading of the air compressors at less than full load conditions, sometimes misdiagnosed as a high load condition. Most of the load/no load controls are set at a 7–10 psig differential, which is monitored at the compressor discharge. When a load/no load compressor is piped into a compressed air distribution system, the control differential of the air compressor is reduced by the pressure drop across the clean-up equipment. Essentially any pressure drop created by filters, dryers and piping will subtract from the controls differential. This could easily result in a true controls differential of 2–7 psig instead of the normal 10 psig and result in a short cycling in the compressor controls. Properly applied control storage will create a buffer between the sensing point of the compressor controls and clean-up equipment providing time to smooth out the compressor controls reaction. Optimally, a control storage ratio of 3–5 gal./ cfm output is recommended.

Variable Displacement

Variable displacement controls are similar to modulation in the fact that as long as the plant load stays within the operational range of this type of control, then control storage is not necessarily required. However, it needs to be understood that the control range of a variable displacement control is narrower than that of a modulation control. Variable displacement control will only operate at loads of 50% or higher. Below 50%, the compressor operation will revert to a load/ no load or modulation control. Should the compressor operate below the 50% level, control storage (3–5 gal./cfm output) should be applied.

Variable Speed Drive (VSD)

Variable speed drive controls are also similar to both modulation and variable displacement

in that as long as the compressor operation is within the operational range of the VSD, a case can be made that control storage provides little benefit. As with the case of the variable displacement control, the operator must be aware of the turndown capability of the VSD, which can vary from manufacturer to manufacturer and even within models of a manufacturer's product line. If the compressor operates below the turndown range of a VSD compressor, then control storage should be applied (3–5 gal./cfm output).

Conclusion

The rationale of utilizing control storage solely as a liquid knockout tank on compressor control schemes that otherwise would not normally require control storage is problematic. In order for control storage to be effective in condensate removal, sufficient cooling and a reduction in velocity of the compressed air would have to take place. While some condensate will be discharged from the system at this location, if the sole function is just condensate removal, the cost of high quality separators and condensate drains on the compressor would be more effective and will produce a much better ROI.

As is the case with all types of storage, knowledge of the compressed air system is required to maximize the value it would add to a compressed air system. Without application knowledge, the benefits of storage can be greatly compromised. Control storage is a tool that can significantly improve the reliability and operation of an air compressor system, but needs to be properly evaluated. It is not possible to cover all the aspects regarding the application of control storage within the contents of this article. There are other specific applications that can arise in the design of compressed air systems that may require the use of control storage. BP

For questions concerning control storage or any other types of storage and related applications, please contact Ron Nordby, John Henry Foster, tel: 651.681.5724, email: ron.nordby@jhfoster.com or visit www.jhfoster.com.

THE TECHNOLOGY PROVIDER

Substance in Sustainability at Atlas Copco

BY ROD SMITH, COMPRESSED AIR BEST PRACTICES® MAGAZINE

Actions speak more loudly than words. Growing up in Kansas, with wheat fields as your neighbor, we were taught to make observations like, "he's a talker", or "he's the fancy-dressed guy". Raw, sometimes menacing, and always waiting to get to the point, we were taught, "If you can't back-up what you're saying, don't say anything." These comments reflected a core Midwestern value – one that values substance. Substance is not a universally held trait and that holds true when firms claim to be good corporate citizens.

Atlas Copco AB is a Stockholm-based multinational corporation primarily focused on technologies used in compressed air and gas systems, generators, and construction and mining equipment. At the end of 2010, the Group employed 33,000 people with revenues of 7.3 Billion Euros. In my role as a journalist and market observer, substance in sustainability is a value I see "backed-up" at Atlas Copco – in terms of measurable metrics and innovative product development.

Substance in the Sustainability Metrics

I was trained to be a business executive and, at the end of the quarter, measurable metrics defined the substance of one's actions. The emergence of Sustainability, Energy Efficiency, and Corporate Responsibility as issues of interest to the consumer has created a buzz-saw of marketing activities and "fancy-dressed brochures". Countless Corporate Citizenship Reports reside on web sites and are filled with images of green trees and blue lagoons. If you want to skip the fancy-talk, however, look to find a companies' metrics on Sustainability and ask them how they report them.

Karin Holmquist manages Corporate Responsibility for Atlas Copco. "In 2000, when we decided to start reporting metrics on sustainability, we found the Global Reporting Initiative (GRI) and implemented their Sustainability Reporting Guidelines in 2001." Focused on advancing Corporate Responsibility and Transparency, GRI provides guidance on how organizations can disclose their sustainability performance. GRI is supported by the United Nations Global Compact (UNGC), the United Nations Environment Programme (UNEP), and the Organization for Economic Cooperation and Development (OECD).

Now on Version 3 of their Reporting Guidelines, one of the great benefits I observe about GRI is that it provides a platform for best practice sustainability reporting. Ms. Holmquist commented, "GRI has three transparency levels – Levels A, B, and C. In 2006, Atlas Copco went to the highest level, Level A transparency reporting on all core indicators."

The 2010 Atlas Copco Annual Report and Sustainability Report integrates financial metrics with GRI sustainability metrics. They enable the understanding of how much energy is used in relation to sales activity. This permits the establishment of Energy Intensity metrics that all can manage to. Ms. Holmquist described the management structure involved, "Direct energy consumption is managed and decided on the company/divisional level. The Atlas Copco companies have assigned the task to environmental managers or Integrated Management System managers who support the work with continual improvements in the ISO 14001 management systems. There is a Group Safety,

> "In my role as a journalist and market observer, substance in sustainability is a value I see "backed-up" at Atlas Copco – in terms of measurable metrics and innovative product development."
>
> — Rod Smith, Compressed Air Best Practices® Magazine

Atlas Copco President and CEO, Ronnie Leten, leads ambitious sustainability goals for the 2010–2020 period.

Health and Environmental (SHE) Council with representatives from business areas and corporate functions where SHE related issues are discussed. Recommendations from the SHE Council are decided by Group Management and implemented by operations."

Atlas Copco President and CEO, Ronnie Leten, outlined ambitious sustainability goals for the 2010–2020 time period in his letter contained in the 2010 Atlas Copco Annual Report. The first commitment is that operations will keep water consumption at current levels – regardless of production levels. The second big one is that CO_2 emissions per cost of sales (an Energy Intensity measure) will be reduced by 20% by the year 2020. The third significant commitment is that the technologies and services provided by the company will increase in energy efficiency by 20% by the year 2020.

1. Operations will decrease CO_2 emissions from operations and transport of goods by 20% in relation to cost of sales by 2020 vs. the base year of 2010
2. Operations will keep water consumption at current levels
3. Products/services/and solutions will increase the energy efficiency of products sold by 20% by 2020 vs. the base year of 2010

TABLE 1: SUSTAINABILITY METRICS AT ATLAS COPCO

GRI INDICATOR*	ENVIRONMENTAL (PRODUCTION UNITS)	2006	2008	2010	2020 GOAL
EC1	Revenues MSEK	60,430	77,370	70,490	
EN8	Water consumption in '000 m3	523	547	524	Keep at Current Level
EN16	CO_2 emissions in '000 tons (total energy)	89	120	113	-20%/COS
EN17	CO_2 emissions in '000 tons (transport)	198	305	197	-20%/COS

* From page 120 of the 2010 Atlas Copco Annual Report.

There is significant substance in the quality of the reporting of the metrics and in the goals set forth by Atlas Copco. The next time one of your suppliers tells you that they are a good Corporate Citizen, ask them what metrics they can supply on sustainability and how they come by their measurements.

Substance in Product Innovations for Sustainability

Product innovation in air compressors, as it relates to energy efficiency, is important due to a percentage of energy losses inherent to air compressor technology. A percentage of energy is lost, as waste heat, through radiation in the compression process. Holmquist commented, "This is why a key sustainability metric is to increase the energy efficiency of products sold by 20% by the year 2020."

THE TECHNOLOGY PROVIDER

Substance in Sustainability at Atlas Copco

Atlas Copco's Commitment to the U.S. Market

Atlas Copco opened, in May 2010, a new 131,000 sq.-ft. national distribution center in Charlotte, N.C., for the distribution of products under the Atlas Copco brand. The new distribution center is located at the Westlake Corporate Campus in Charlotte. The new facility is forecasted to process 476,000 orders annually and an average of more than 1,000 parcels per day. This custom-fitted facility will become the central distribution point for a wide variety of compressors, medical gas equipment and industrial and vehicle service tools, as well as thousands of spare parts. This increased parts capacity means our customers in North America can now receive 24-hour delivery on all stocked parts.

Atlas Copco booth at 2011 World Energy Engineering Conference.

Atlas Copco Compressors, including an expanded manufacturing facility for the Atlas Copco portable and stationary compressors, will remain in Rock Hill, S.C. The facility is also undergoing an expansion of production lines for generators.

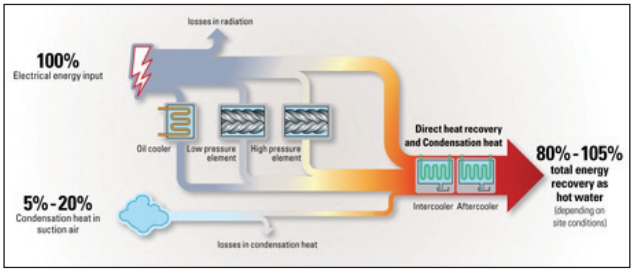
The correct application of technologies remains the most important technique in reducing energy costs. Knowing when to use what technology in what application requires extensive training and experience. Atlas Copco distributors and sales and service personnel train to provide customers with the best-designed compressed air systems. To this end, Atlas Copco has invested in a 3,200 square foot custom-built facility that is split into classroom and a practical work area. All equipment in the training room utilizes compressed air, which allows instructors to provide insights into techniques on building customized product configurations, stripping and troubleshooting. Classes are also conducted on Elektronikon and the company's AirOptimizer and Air Connect monitoring systems.

Atlas Copco supports the Stewart-Haas NASCAR Racing Team.

Woodward Compressor Sales, Inc., based in Charlotte, N.C., represents Atlas Copco products.

Heat recovery represents a significant energy-saving opportunity for compressed air users as a significant percentage (up to 94%) of the thermal energy can be recovered. Atlas Copco has introduced heat recovery packages, matching their air compressors, designed to provide low-grade heat to heat air or water to 140 ˚F (90 ˚C).

Atlas Copco introduced, in 2011 at the Hannover Fair, the new ZH 350+ oil-free, high-speed drive centrifugal air compressor. The company says



Thermal energy, captured from air compressors as a heat recovery project, can provide low-grade heat for industrial uses.

THE TECHNOLOGY PROVIDER

Substance in Sustainability at Atlas Copco

The new oil-free, centrifugal, three-stage ZH 350+ air compressor

it's the first three-stage centrifugal air compressor with high-speed motors and without a gearbox. According to company product literature, the ZH 350+ is 4% more efficient than the company's top-performing oil-free air compressors due to five design characteristics.

1. The three-stage turbo design is widely recognized as the most efficient design for achieving compression between 7 and 11 bar
2. Elimination of the gearbox and thereby the transmission losses capable of resulting in a reduction of energy efficiency of up to 9% in compressors in the 350 kW range
3. Titanium impellers permit faster load-unload cycles. The gain in speed results in reduced power losses during low-demand periods
4. Optimally sized coolers reduce pressure drop
5. The system blows off before the aftercooler meaning that minimal compressed air is lost when demand decreases

Another new product, introduced in 2011, will improve energy efficiency for food, electronics and pharmaceutical industries requiring -40 ˚F (-40 ˚C) pressure dewpoints. The ND Series heat of compression rotary drum dryer can now provide this dewpoint level while consuming virtually no energy. In the past, these customers typically purchased desiccant air dryers with up to 15% compressed air purge losses.

Other product innovations, introduced in 2011, include variable speed blowers designed for partial load applications (like wastewater treatment plants). The wastewater industry is realizing their aeration processes are not fixed-speed applications. A new nitrogen generator allows plants to self-generate nitrogen and reduce the sustainability footprint associated with the transport and delivery of nitrogen to their facilities. With these products, Atlas Copco is off to a fast start in achieving the 20% improvement in energy efficiency metric.

Conclusion

As a publisher and journalist, I observe a lot of "green-washing" from firms claiming energy efficiency and sustainability. Substance behind claims is not always to be found. Atlas Copco has demonstrated significant substance in sustainability claims in both how they report their performance and in the products brought to market. BP

The new ND heat of compression rotary drum dryer provides a -40 ˚F dewpoint with virtually no energy cost.

THE BIGGEST & WORST:

Tales from a Compressed Air System Auditor's personal notebook

BY CHRIS E. BEALS, PRESIDENT OF AIR SYSTEM MANAGEMENT, INC.

KNOW PRESSURE COMPRESSED AIR CHALLENGE®

Before venturing off into compressed air consulting myself, I listened to compressed air consultants' stories about the amazing things they encountered during their compressed air system reviews. At that point, without having any system experience myself, I thought they might be making these things up or at least exaggerating them; however, after conducting compressed air system reviews for the past 13-years I can confirm I have encountered everything they mentioned and more. And some things, such as, being able to shut off ALL the compressors and dryers in a large oil refinery were inconceivable before I encountered them.

You may have heard some of the following stories if you've attended one of the Compressed Air Challenge's "Fundamentals of Compressed Air Systems" seminars offered by the Compressed Air Challenge throughout the US and Canada. If not, I hope these items will at least make you smile.

Maybe You Don't Need Those Controls That Come On Your Compressor

Manufacturers supply compressors with controls so it can efficiently match the supply to the demand and most importantly operate safely, and prevent damage to various compressor components or operators. However, some plants erroneously choose to operate without them. For example, a steel mill had six 600 hp lubricated rotary screw compressors. When we tried to determine the operating set points of each compressor by slowly closing its isolation valve while measuring the amps and pressure; the pressure and amps kept rising until the safety relief valve blew. When the second compressor did the same thing we asked the operator, "How do you control the compressors?" to which he answered, "When we hear the safety relief valves blowing we shut one down". You might think this was an isolated case; however, in a paper mill when we couldn't find any controls on several large reciprocating compressors we asked the operators, "How do you control the compressors?" to which they answered, "When we hear the safety relief valves blowing we shut one down".

AIR BEST PRACTICES™

Our record for the biggest pressure drop across a coalescing filter is 51 psi.

Fundamentals of Compressed Air Systems WE (web-edition)

Join us for the next session of *Fundamentals of Compressed Air Systems WE* (web-edition) coming February 20th, 2012. Led by our experienced instructors, this web-based version of the popular *Fundamentals of Compressed Air Systems* training uses an interactive format that enables the instructor to diagram examples, give pop quizzes and answer students' questions in real time. Participation is limited to 25 students. Please visit **www.compressedairchallenge.org**, to access online registration and for more information about the training.

If you have additional questions about the new web-based training or other CAC® training opportunities, please contact the CAC® at **info@compressedairchallenge.org**.

BIGGEST Pressure Drop across Inlet Filters and Piping

Years ago, while managing the service department of my compressor distributorship, I received a call from a nearby customer who told me his 200 hp compressor wouldn't make any air. When I arrived at the plant I found the inlet air filter differential indicator showing "Red", which indicates the filter element was dirty. When I pointed this out the maintenance manager said he had just changed the filter element; however, when I removed the element the compressor immediately started making air. He then admitted that the element was one that they had simply washed out approximately seven times before. Unwittingly, when he tried to save money by cleaning the filter element he was increasing his energy cost several times more than the cost of the element.

Our record for the biggest pressure drop across the inlet filter and piping on a centrifugal compressor is 4.2 psi measured upstream of the inlet valve. High inlet pressure differential on the inlet side of a centrifugal compressor reduces its capacity, lowers the natural surge pressure, and limits the turndown making them unstable and inefficient. In one case, we encountered a new centrifugal compressor that had been sitting idle for five years because it surged at its design operating pressure. We found piping for intake air undersized. After increasing the inlet pipe size the compressor now operates fine. In another case, we found that personnel had left the startup strainers, used during startup to prevent welding slag and other debris from damaging the compressor, in the inlet piping to their centrifugal compressors for years.

THE BIGGEST & WORST

After removing the strainers and load-sharing across the operating compressors, the total power reduced by over 200 kW.

BIGGEST Air/Oil Separator Pressure Drop

Our record for the biggest pressure drop across an air/oil separator in a lubricated rotary screw compressor is 34 psi and the compressor next to it had a 22 psi drop. The air/oil separator is used to separate the majority of the oil from the air before the air exits the compressor. Typically, an air/oil separator allows between 1 and 5 ppm of oil per cubic feet of air to carry over into the system; however, as the pressure drop increases the velocity through the air/oil receiver increases, which increases the oil carryover. These large pressure drops shouldn't have occurred because the compressor controls were supposed to shut the compressor off when the pressure drop reached 15 psi. In addition, given this pressure drop the motor overloads should have shut down the compressor. Needless to say these safeties were dangerously bypassed. In another plant, bypassing the motor overloads when the air/oil separator had an excessive pressure drop proved just how dangerous this can be. We found a 75 hp compressor pulling power equal to 100 hp. We told plant personnel there was a serious problem with the compressor, but two weeks later the compressor exploded – luckily no one was hurt.

BIGGEST Pressure Drop across an Orifice Plate

Our record for the biggest pressure drop across an orifice plate in an orifice style flow meter is 27 psi instead of the expected 1.5 to 2.0 psi. We have also found orifice plates with pressure drops of 9 and 18 psi. In addition, in many plants we encounter pressure drops caused by installing several orifice style flow meters in series.

BIGGEST Pressure Drop across a Coalescing Filter

Our record for the biggest pressure drop across a coalescing filter is 51 psi. One of our clients requires an audit of a plant before that plant can install an additional compressor, so we were sent there to review the compressed air system. When we arrived the compressor was operating at 116 psi; the plant pressure was only 55 psi. The pressure drop across the dryer and filter measured 61 psi with 51 psi across the filter only. Needless to say the filter wasn't installed with a pressure differential indicator.

BIGGEST Pressure Drop across a Desiccant Dryer

Our record for the biggest pressure drop across a desiccant dryer is 34 psi. The system pressure in the instrument air system was 55 psi. Not knowing why the pressure was so low, personnel started operating critical control valves off the optional wet plant air headers.

BIGGEST Pressure Drop in Headers

We have found over 60 psi drop in a few main headers, which were caused by:

- A broken 2-inch header that was leaking 845 scfm to atmosphere
- An open 2-inch valve blowing 740 scfm to atmosphere
- 625 scfm of purge air blowing into a boiler to prevent the catalyst from blowing out

The first two items can also be considered the biggest single air leaks we've found.

Another plant had what appeared to be two separate compressor systems because one was operating at 115 psi, while the other operated at 67 psi. We questioned personnel when they told us the systems were connected; but they showed us the 300 ft 2-inch header connecting the systems. The flow in the 2-inch header was 1067 scfm rather than the typical 180 scfm.

BIGGEST Demand Side Reduction

In a refinery, we found personnel using 2525 scfm to cool the view ports, on their waste heat boilers, at an annual cost of $169,300. Personnel were able to reduce the cooling air flow to 261 scfm.

CAC® Qualified Instructor Profile

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Chris is designated as an **Energy Expert** for Compressed Air by the United States Department of Energy and is a founding member of the Compressed Air Challenge. In addition, Chris is Air Master Certified, a CAC Certified L1 instructor, and was a member of the Core Technical Group responsible for developing the training materials for the Compressed Air Challenge Seminars.

BIGGEST Dust Collector Demand Reduction

In the converting department of a paper mill we were able the reduce the dust collector demand by 1100 scfm by installing dedicated storage with metered recovery and pulsing them off a Photohelic gauge. We did almost as well at a copper mine when we reduced their dust collector demand by 800 scfm.

BIGGEST Number of Compressors Shut Down in One Plant

Our record is six compressors and no they didn't install any new ones. They had 11 compressors all load sharing – or possibly operating in modulation and load sharing. We achieved this by automating the compressors, operating them in load/unload mode, and by reducing demand. We have equaled this record at two other plants.

BIGGEST Single Compressor Shutdown

In a refinery, we were able to shut off one of six 2000 hp 8000 cfm compressors that operated fully loaded with no blow off. This also qualifies as our record for the most total horsepower turned off and which we have equaled one other time.

BIGGEST Artificial Demand Reduction

By reducing the pressure, by 10 psi, in a paper mill that consumed over 20,000 scfm we were able to reduce demand by almost 2,000 scfm, because little of the air was regulated.

BIGGEST Number of Leaks

Our record of 2703 leaks occurred in a refinery; which also captured the biggest leak rate of 6,916 scfm. We have also found a leak rate of 6,519 scfm in a tire manufacturing plant.

BIGGEST Surprises or Most Amazing Results

A refinery wanted to reduce their emissions so we were asked to review the compressed air system and then size two new electric-motor driven compressors to replace the two 2000 cfm natural-gas driven reciprocating compressors. After the review, we told them they didn't need any new compressors and all they need to do to reduce their emissions was to shut off the two compressors. When personnel shut off the compressors the pressure dropped 3 psi and then stabilized. At another refinery, after the review we showed personnel how to shut off all of their compressors and dryers.

How you ask? Before we could make these recommendations we had to visit the nitrogen plants that supplied nitrogen to each refinery. In many cases, the nitrogen plants also supply compressed air. In the first case, we found that the nitrogen plant was blowing off 4795 scfm, to atmosphere, because the pressure in the refinery was too high, so when personnel shut off the natural-gas driven compressors the pressure dropped 3 psi and the air that was being blow off flowed into the refinery. In the second case, the nitrogen plant had a contract with the refinery to supply 26,000 scfm of compressed air; the headers, between the plants, were too small so the refinery could only take 7650 scfm, of compressed air, from the nitrogen plant. We designed a new header system that would allow the refinery to access the full capacity of the nitrogen plant and shut down their compressors and dryers and save $1,923,425 annually. BP

ENERGY CONSERVATION INCENTIVES

Retro-commissioning Incentives for Compressed Air Systems with Wisconsin's Focus on Energy

BY NATHANIEL Q. ALTFEATHER, ENGINEERING MANAGER, SAIC

Abstract

This paper discusses the challenges and successes encountered while creating a retro-commissioning offering for industrial compressed air systems. The pilot program succeeded in enrolling seven different manufacturing facilities that, combined, represented more than 5,475 connected compressor horsepower. Five of the seven companies completed the pilot program and captured more than 2.3 Million annual kWh at an incentive cost of less than $0.03/kWh for the first year's savings.

Background

The EPA defines building commissioning as a "quality assurance program intended to demonstrate the building is constructed well and performs as designed" (EPA, 2010). Whereas standard commissioning occurs during or just after initial construction, retroactive commissioning or retro-commissioning simply refers to accomplishing those same goals retroactively to an existing system. Retro-commissioning is different from a standard energy assessment in that it strictly looks for opportunities to maximize the performance of the existing system as opposed to suggest new equipment or technology to replace the existing system.

The targeted opportunities during retro-commissioning are often no or low-cost and involve repairing malfunctioning components within the system or adjusting system controls to more closely match current system demands. Although building commissioning has gained considerable visibility in recent years, the commissioning concept can be applied to any engineered system that requires interactivity between multiple components to perform correctly.

Prior to the development of the compressed air retro-commissioning program discussed in this paper, Wisconsin's state-wide energy efficiency program, Focus on Energy, developed and released a commercial building retro-commissioning (RCx) incentive. The commercial building RCx incentive still exists today and requires an assessment that focuses on low and no-cost opportunities associated with a building automation system (BAS) and the heating, ventilation and air conditioning systems controlled by the BAS.

Since the inception of the commercial building RCx incentive multiple industrial customers have inquired about that offering but have opted not to participate because the building system approach did not address the production related systems that are often the focus of industrial energy efficiency efforts. In response, the industrial office of the Focus on Energy program set out to develop a retro-commissioning offering

that would address energy-intensive systems such as compressed air, steam, chilled water and industrial ventilation that are commonly found in industrial environments.

It quickly became apparent that developing a single assessment procedure that would address all of these systems would be too daunting. Instead the industrial office decided to develop an approach and accompanying incentive for each system that could benefit from an RCx assessment approach. Compressed air was chosen for the first pilot program due to technical familiarity and universality to most industrial environments.

Program Design

There are two parts to the compressed air retro-commissioning incentive design. The first part involved designing an assessment that would achieve the retro-commissioning goal of uncovering low and no-cost opportunities with the customer existing equipment. The second part required creating an incentive structure that minimizes program risk while at the same time offering enough incentive to overcome customer barriers to participation.

Assessment Design

The goal of a retro-commissioning assessment is to uncover opportunities within the customer's existing equipment. These opportunities often take the form of controls programming changes to reflect process changes that have occurred over time, or replacing system components that have failed. The process of uncovering these opportunities is labor intensive and expensive but the benefits can be very inexpensive.

The basic concept of a RCx assessment consists of two parts. The first is to document the original performance specification of each system component and how the components should interact under different operating conditions. The second is to take the required measurements and perform the necessary investigations to verify that each system component and the system as a whole perform in accordance to those specifications.

To apply this framework to compressed air the Wisconsin Focus on Energy program created individual performance verification worksheets for the common compressed air system components. Worksheets were created for compressors, dryers, distribution system, sequencing controls, and leak documentation. These worksheets required the assessment provider document the performance specification from the original manufacturer specification sheets, compare this to what the customer actually requires based on current compressed air uses, and then the worksheet required the assessment provider to document how each component is actually performing after the field measurements and data are collected.

The performance of all the system components working together was measured by requiring the assessment provider measure actual power and actual flow at all points necessary to develop a Compressed Air Supply Efficiency (CASE) number. The CASE number for a system is the average scf/kWh for one week where scf is measured downstream of all supply side equipment, and kWh includes energy consumption of all supply side equipment (Babu, 2004).

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ENERGY INCENTIVES

Retro-commissioning Incentives for Compressed Air Systems with Wisconsin's Focus on Energy

Incentive Design

Retro-commissioning level assessments have a high upfront cost and uncover low or no-cost opportunities. The high upfront cost is a barrier in and of itself, but it is compounded by the fact that a customer must incur the high cost before knowing what benefits will result.

This high cost is in contrast to the low or no-cost assessments offered by equipment sales companies where the assessment is offered for a low price or for free, but the opportunities uncovered are often limited to significant investment in new equipment.

To overcome the market barrier of high upfront cost with unknown benefits, a successful demand-side management (DSM) retro-commissioning program must offer an incentive sufficient in size to remove enough risk for the customer that the customer is willing to invest in the higher-cost assessment. But the program must be careful not to assume the entire risk of unknown benefits by building risk-mitigating components into the incentive.

To address the high upfront cost barrier the Focus on Energy program offered $15 per active (non-backup) compressor horsepower towards the cost of the retro-commissioning assessment not to exceed $25,000. The incentive amount was determined using program minimum cost-effectiveness targets and assumed minimum savings from minimal leak repairs that would be required by all participants in the compressed air RCx program.

In return for the larger incentive applicants must agree in advance to implement all projects identified with a simple energy payback of 1.5 years or less or spend at least $15 per horsepower towards those projects.

The $15 per horsepower incentive is almost four times larger than what the Focus on Energy program previously offered towards a basic compressed air audit. The previous basic compressed air audit incentive did not require the customer implement any of the identified opportunities. The larger incentive for the RCx approach is justified because the RCx incentive design will require the customer implement identified projects allowing the program to offer a higher incentive and remain cost-effective.

The table below explains the requirements and features built in to the incentive to maximize the potential for savings and protect the program from risk of funding an assessment that results in no opportunity for efficiency improvement.

Program Implementation

Rather than use traditional program outreach channels for releasing this offering to the broader market, the compressed air RCx pilot program was released only to the compressed air market providers through a roll-out meeting. Providers who wished to participate in the pilot program were required to attend this roll-out meeting where details of the offering were released. Other than required attendance at the kick off meeting, the pilot program did not restrict who could be an assessment provider. Any contractor who could perform the required assessment activities was free to participate.

The reason the program roll out was handled through the market providers is that it was assumed that market providers have the best knowledge of their own customer's systems and would know the best system to target for such an offering. Mass market advertising was avoided due to the limited spots available in the pilot.

INCENTIVE FEATURES TO REDUCE PROGRAM RISK	
FEATURE	**EXPLANATION OF RISK REDUCTION**
Leak survey and repair required	Guarantees savings can be claimed from leak repairs for every applicant regardless of other uncovered opportunities
Application must agree to implement all projects with simple paybacks up to 1.5 years or spend $15/ active hp towards those projects	Guarantees good projects will be implemented, but also caps the maximum customer obligation/exposure
Assessment provider must make the case in the application that the applicant's system is likely to have savings opportunities	Reduces the likelihood of paying for an assessment that doesn't find any opportunity
Applicant must have at least 200 active compressor horsepower	Small systems are less likely to have the complexity that lends itself well to retro-commissioning activities

ENERGY INCENTIVES

Retro-commissioning Incentives for Compressed Air Systems with Wisconsin's Focus on Energy

"The pilot program succeeded in enrolling seven different manufacturing facilities that, combined, represented more than 5,475 connected compressor horsepower. Five of the seven companies completed the pilot program and captured more than 2.3 Million annual kWh at an incentive cost of less than $0.03/kWh for the first year's savings."

— Nathaniel Q. Altfeather, Engineering Manager, SAIC

Features of the pilot implementation were:

- Program limited to 10 compressed air systems total
- Each assessment provider was allowed a maximum of 2 customers in the pilot program on a first-apply-first-serve basis
- Program duration was approximately one year
- Identified projects must be completed by conclusion of program
- Incentives are paid to the customer after projects are implemented

Results and Lessons

The table below summarizes the results of the compressed air retro-commissioning pilot program. The customer names have been replaced with letters for identification purposes for the remainder of this paper. The columns in the table are defined as follows:

- **System Hp –** the system horsepower represents nameplate horsepower for active, non-backup compressor capacity
- **Total Customer Cost –** the cost of the initial RCx assessment and any costs that the customer incurred implementing the identified opportunities
- **kW Saved –** an average kW reduction determined dividing the energy savings over the hours of system operation (not to be confused with peak kW reduction)
- **kWh Saved –** the annual estimated energy savings resulting from the implementation of measures identified during the RCx assessment
- **Incentive –** the total financial incentive paid to the customer at the conclusion of the program

SUMMARY OF PILOT PROGRAM RESULTS

CUSTOMER	SYSTEM HP	TOTAL CUSTOMER COST [ASSESSMENT + REPAIRS]	KW SAVED	KW SAVED	INCENTIVE
A	1,000	$41,500	79	573,161	$16,125
B	800	$25,294	66	507,769	$12,000
C	500	$14,500	48	423,320	$7,500
D	500	$7,500	35	305,549	$7,500
E	-	DNF	NA	NA	NA
F	1,200	$25,000	41	553,601	$22,500
G	-	DNF	NA	NA	NA
Total	**4000**	**$113,794**	**269**	**2,363,400**	**$65,625**

Customer A is a large fabrication and assembly company and the assessment results did not contain the low and no-cost opportunities that the program hoped to uncover. During the post-assessment interview, the Focus on Energy representative found that the facility had large open-blowing tubes underneath a stamping machine to blow the stamped part out of the mold. It was also discovered during the exit interview that at time the entire plant remained pressurized over the weekend simply to feed a single EDM machine. An existing stand-alone compressor for this machine had failed, and the machine was simply hooked to the central compressed air system. Unfortunately there wasn't time or budget for the vendor to investigate these opportunities in time for the offering deadline. The savings claimed for this customer were from leak repair only.

Customer B a furniture manufacturer has 925 hp of air compressors. During the assessment it was discovered that a bypass valve on a 300 hp air compressor was stuck open. The repair was authorized immediately the day of the assessment. The repair cost was $1,600 and the resulting energy reduction will save the customer approximately $32,000 per year.

Customer C, a metal parts manufacturer has five 100 hp compressors. Over the years dozens of open blowing applications have been installed to facilitate the movement of small parts through the automated machining centers. These open tubes are estimated to represent more than 500 cfm of air demand. The RCX assessment recommended that customer install nozzles on each of these tubes to reduce the free flow of air. The customer responded that they had already tried a nozzle and it "didn't work". However because of the RCX structure they were required to investigate more nozzle types in order to receive the incentive and they eventually found a nozzle that worked. 51 nozzles were installed that reduced air flow from at each open tube by 50%. The cost to purchase the nozzles was $1,245 the reduction in CFM will save the customer approximately $33,000 per year in energy costs. A program representative was included at both the initial sales meeting for the pilot program as well as the exit meeting.

Customer D, a PVC pipe manufacturer has six (6) 50 hp compressors and two (2) 100 hp compressors in 3 different buildings. All of the compressors feed into one system and piping runs between four buildings on the campus. The power and flow monitoring during the RCx assessment uncovered the fact that one of the 100 hp compressors was stuck in idle mode. The damaged idle linkage caused the compressor to run 24/7 without compressing any air. There would've been no way for the system owner to know the compressor was not producing air without the detailed monitoring of the RCX assessment. The malfunctioning control was fixed by the assessment provider for $623 and saved the customer over $10,000 per year in energy costs. A program representative was included in both the initial proposal meeting as well as the exit meeting after the assessment.

Customer E, a large industrial printer, struggled to install the required metering without interrupting production. Delays in the logistics of carrying out the assessment pushed the project beyond the program deadline and the program did not pay an incentive or claim any savings from this customer.

Customer F a plastic bottle manufacturer has six air compressors totaling more than 1500 hp worth of capacity. During the RCX assessment it was discovered that one compressor was not tied into the central compressor control system. It was estimated that bringing the compressor into the control scheme would save almost 250,000 kWh per year. The system owner investigated and found out that actually the compressor was tied in the control system the controls simply weren't "activated". With the flip of a switch the customer saved almost $20,000 per year in electricity costs.

Little is known about the assessment for Customer G as the vendor did not include the program in any of the customer interactions. The assessment report was submitted but the customer did not act on any of the recommendations and therefore did not receive an incentive.

At the conclusion of the pilot program the total incentives paid by Focus on Energy came to $65,625. In return the program was able to claim more than 2.3 million kWh. Dividing the kWh into the total incentive cost gives an incentive cost-effectiveness of less than $0.03/kWh.

PROGRAM COST EFFECTIVENESS	
Program Incentive Cost	$65,625
Gross Savings Achieve [kWh]	2,363,400
Cost Effectiveness [incentive $/kWh]	$0.027/kWh

ENERGY INCENTIVES

Retro-commissioning Incentives for Compressed Air Systems with Wisconsin's Focus on Energy

Pilot Program Objectives and Outcomes

The table below looks at the overall success of the pilot program by comparing pilot objectives with the outcomes of the pilot program.

OBJECTIVE	OUTCOME
Achieve Cost-Effective Savings	The offering succeeded in capturing more than 250kW and over 2.3 Million kWh for the Focus on Energy program for less than 75% of the cost of typical program incentive for the same savings.
Focus on low and no-cost opportunities to improve the efficiency of existing equipment	Initially this was difficult for providers to grasp as they are used to looking for opportunities to sell new equipment. However the concept was quickly adopted as providers realized this was a value-added service the incentive enabled them to offer. No and/or low-Cost opportunities were identified at all participant sites.
Overcome the high-cost barrier to a comprehensive assessment	Based on the ability of service providers to sell this offering it appears the incentive level is adequate. There have been multiple inquiries as to the RCX's availability for 2011.
Focus the assessment provider's attention on the often overlooked distribution and demand side of compressed air systems	Most compressed air service providers are in the business of selling supply-side equipment and the current assessment offerings in the market place reflect this by focusing attention on the compressor room. Few of the RCX assessments provided the in-depth demand side assessment expected it is recommended changes be made to more clearly define assessment activities in future RCX offerings.

Lesson Learned

Service providers did a good job of identifying customers who were good candidates for the RCx program and did a good job selling the concept to theses customers. All but one company approached with the RCx concept eventually enrolled.

Participants were not frightened by the prospect of committing in advance to implement projects with a 1.5 year payback. The 1.5 year payback seemed to be an acceptable return for the companies approached with the RCx concept. Even the company that failed to enroll stated that the 1.5 year payback was an acceptable commitment.

Two of the seven applicants did not include a Focus on Energy representative at the initial kick-off meeting. These two applicants were the only two that did not successfully complete the compressed air RCx program before the incentive deadline. Involvement of the demand side management program staff is critical to the success of RCx. Future offerings should make it a strictly enforced requirement that a program representative must be at the initial kick-off meeting.

Many of the service providers involved already offered some type of compressed air system assessment. Many times the required RCx assessment activities did not align with the providers typical assessment activities. Initially providers were confident they could meet the additional requirements of the RCx assessment. In practice the RCx activities such as kW monitoring and flow measurement were harder for most providers to complete than originally thought. Future RCx offerings will use the lessons learned to develop a more complete but also more realistic set of required activities to qualify for RCx.

Compressed air equipment providers are not necessarily experts at demand-side equipment efficiency or design. During post-assessment meetings the Focus on Energy representative was able to uncover demand-side opportunities not investigated during the assessment. Future RCx offerings need to create a list of common demand-side opportunities and require program staff work closely with assessment providers to be sure those opportunities are fully investigated during the assessment.

Enforcing the detailed assessment requirements was very difficult. Each customer site and assessment provider is unique and trying to enforce a universal set of assessment activities across all the system was difficult. Many times during the pilot program assessment providers could not complete specific required assessment task because the task was either physically or economically unfeasible. Only one provider successfully completed all of the equipment worksheets and ironically that assessment uncovered the smallest number of opportunities.

Conclusion

Typical low-cost compressed air assessments are too focused on new equipment sales and overlook tremendous opportunity for savings that exist within the existing compressed air system. This compressed air retro-commissioning pilot program demonstrates that with the proper assessment scope and sufficient funding these opportunities can be uncovered by DSM program and create very cost effective savings. BP

For more information contact Nathaniel Q. Altfeather, Engineering Manager, Focus on Energy Industrial Program, SAIC, tel: 608-277-2949, email: Nathaniel.q.altfeather@saic.com, www.saic.com/EEandI

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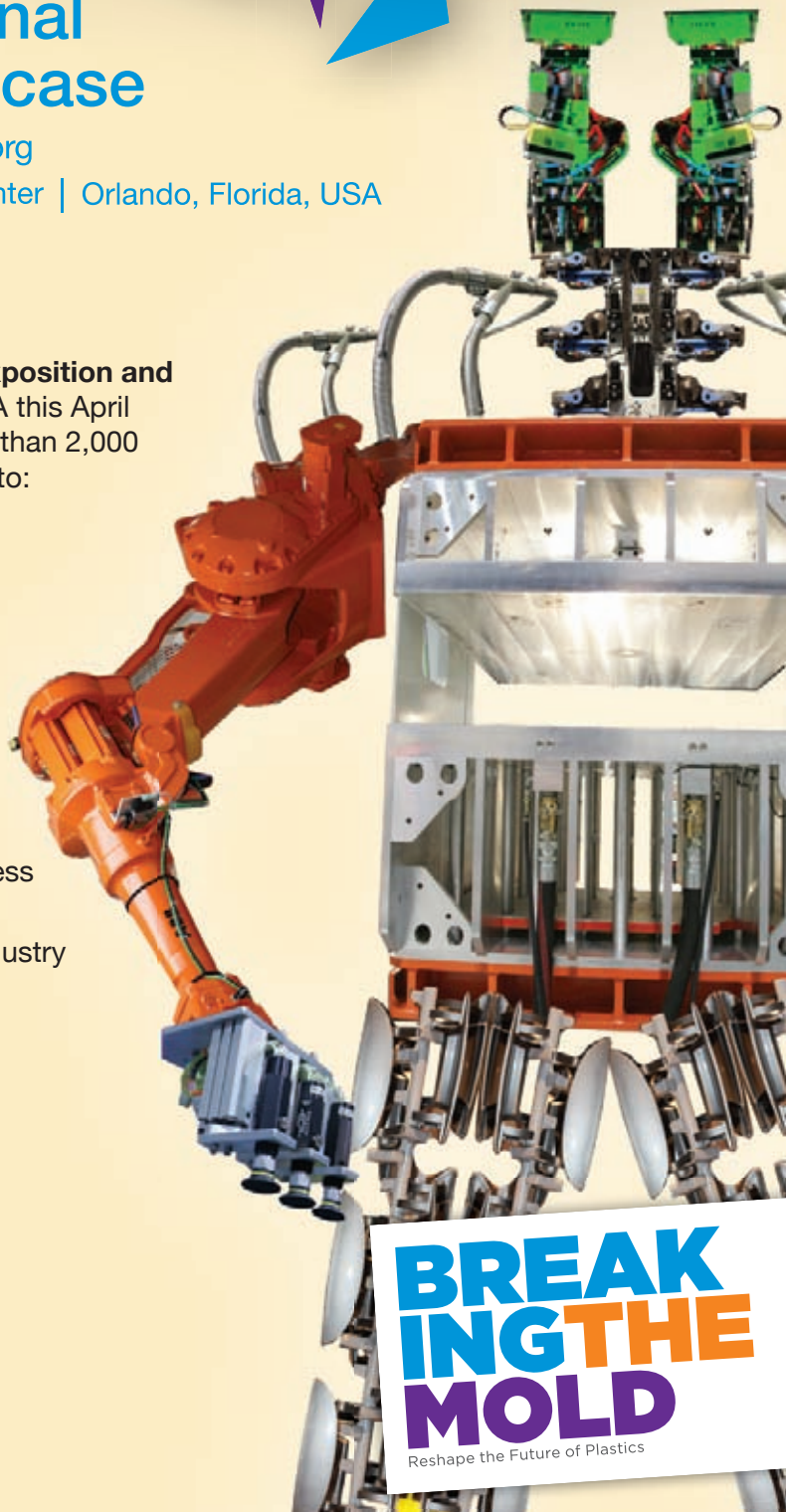

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Energy Efficient Hydraulics and Pneumatics Conference	November 15–17, 2011	Sheraton Chicago O'Hare, Rosemont, Illinois, Chicago, IL	International Fluid Power Society (IFPS), the FPDA Motion and Control Network (FPDA), and the National Fluid Power Association (NFPA)
Fundamentals of Compressed Air Systems	November 16, 2011	Yakima, WA	DOE EERE, Compressed Air Challenge, Ecos Consulting, NEEA Pacific Power
Fundamentals of Compressed Air Systems	November 29, 2011	Lenexa, KS	DOE EERE, Compressed Air Challenge, Hughes Machinery
Advanced Management of Compressed Air Systems	November 30–December 1, 2011	Lenexa, KS	DOE EERE, Compressed Air Challenge, Hughes Machinery
Fundamentals of Compressed Air Systems	December 15, 2011	Greenwood Inn, Winnipeg, MB	Manitoba Hydro Performance Optimization Program and the Compressed Air Challenge
Fundamentals of Compressed Air Systems WE	February 20, 2012	Webinar	Compressed Air Challenge

Editor's Note: If you conduct compressed air system training and would like to post it in this area, please email your information to rod@airbestpractices.com.

PRODUCT NEWS

AST Announces New Pipe Size

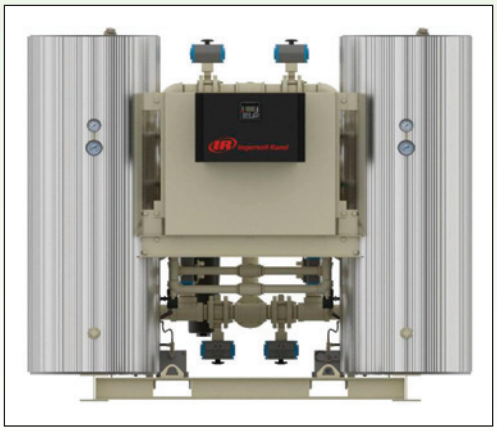
Following the successful launch of the 168mm (6") size earlier this year, 'Applied System Technologies' (AST) has added 70mm tube and fittings to their Elevation piping system. Using a groove fitting design, the system provides the benefits of aluminum tubing, such as non-introduction of contaminants and higher flow rates with a system that is one-tenth the weight of a conventional piping system and can often be installed in less than half the time.

The Elevation system provides a simple solution for large air/inert gas/vacuum users and can be easily combined with AST's Infinity product range with all metal 'push to connect' fittings combined with aluminum tubing from 63mm (2 ½") down to 20mm (3/4") bore sizes. The entire piping system is rated to 220 psi with safe working temperatures from -4 ˚F to 176 ˚F and can offer straight line flow rates up to 11,194 cfm. The range of fittings provide system flexibility for modification and additions, meaning that system layout changes can be achieved quickly and cost effectively — with minimum downtime and disruption to processes.

Contact AST
Peter Glidden
Tel: 704.947.6966
Email: peter@appliedsystemtech.com
www.appliedsystemtech.com

PRODUCT NEWS

Ingersoll Rand Announces New HOC Dryers



Ingersoll Rand announced a new line of heat-of-compression (HOC) dryers.

Ingersoll Rand HOC dryers provide flexibility, reliability and energy efficiency in a low profile package. By using heat produced during the compression process, Ingersoll Rand HOC dryers can deliver instrument-quality air. The HOC dryers feature Smart Control technology which maximizes savings under all operating conditions. By monitoring inlet process air conditions, Smart Control technology adjusts dryer operation to deliver consistent, dry air and helps minimize dew point and temperature spikes.

The Ingersoll Rand HOC dryers feature no-loss drains to prevent the wasting of valuable compressed air, and a low pressure drop design which allows compressors to run at lower pressure, thereby conserving energy. Patented heat exchangers, constructed with stainless steel, provide optimal performance under the harshest operating conditions and the automatic drain bypass feature ensures removal of condensate.

The low profile design fits in installations with low overhead clearances. The low profile design places critical service components within easy reach, resulting in a safer work environment for service personnel. Unlike other HOC dryers, the dryers can be used with multiple compressors, reducing footprint requirements and installation costs.

To put energy efficiency in perspective, consider the estimated annual operating cost of a 1,000 SCFM application at $.10 / kWh. Taking into account the cost of compressed air for purge requirements and electricity, a heatless desiccant dryer would cost over $24,000.00 to operate annually, while a blower purge desiccant dryer would run about $18,000.00 per year. An Ingersoll Rand water-cooled HOC dryer, under the same conditions, would cost approximately $120.00 to operate annually.

Contact Ingersoll Rand
www.ingersollrandproducts.com

New Kaeser Leak Detection and Repair Program

The U.S. DOE estimates that an average of 25% of compressed air is lost to leaks. Kaeser's new Leak Detection and Repair Program employs the latest generation in ultrasonic leak detectors with data logging. Kaeser's service includes a detailed report that provides the magnitude of each leak so that the biggest problems can be tackled first. Users have the option to fix leaks themselves or Kaeser can do it. Either way, energy consumption is reduced and the bottom line improved.

Contact Kaeser Compressors
Tel: 877-586-2691
www.kaeser.com/fixleaks

RESOURCES FOR ENERGY ENGINEERS

PRODUCT NEWS

UE Systems Announces Emissions Readings In Leak Surveys

UE Systems, the industry's leading manufacturer of portable and continuous ultrasonic instruments for leak detection, has secured the patent for a method of calculating and reporting greenhouse gas emissions from a leak survey. The emissions readings are now installed as part of the company's Ultratrend data management software. The Ultratrend DMS can now create reports that, along with providing compressed air leak information, also breaks down gases such as carbon dioxide, nitrogen oxide and sulphur dioxide. The greenhouse gas data measurements are based on state electricity profiles by the Energy Information Administration; Office of Coal, Nuclear, Electric and Alternative Fuels; and the U.S. Department of Energy.

Traditionally, when taking a comprehensive leak detection survey, all data collected from using one of UE Systems' digital instruments is downloaded to the Ultratrend DMS, which filters the data and allows the user to set up a report on an excel spreadsheet. The survey allows the user to store information in each tested group location, converting the decibel levels of each leak into CFM measurement, which is used to calculate both the cost of a leak and the amount of greenhouse gases generated by producing the electricity used to compress the air that is wasted. In addition to greenhouse gases, the software is also used for other gases such as compressed air, argon, helium, hydrogen and nitrogen.

The motivating factor behind creating and implementing a compressed gas report has always been to assist reporting for compressed air leaks, which has long been and remains one of the most costly utilities found at plants. Through prompts on the spreadsheet, users can adjust the cost factors for their geographic area, and make shifts depending upon whether the plant is operational 24 hours a day or less. And with the patented technology, users can now also change their greenhouse gas usage numbers based on their region.

Contact UE Systems
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FilterSense Dust Collector Diagnostics

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WALL STREET WATCH

BY COMPRESSED AIR BEST PRACTICES®

The intent of this column is to provide industry watchers with publicly held information, on publicly held companies, involved with the sub-industry of compressed air. It is not the intent of the column to provide any opinions or recommendations related to stock valuations. All information gathered in this column was during the trading day of November 25, 2011.

NOVEMBER 25, 2011 PRICE PERFORMANCE	SYMBOL	OPEN PRICE	1 MONTH	6 MONTHS	12 MONTHS	DIVIDEND (ANNUAL YIELD) 12 MONTHS
Parker-Hannifin	PH	$75.79	$81.15	$90.14	$81.46	1.95%
Ingersoll Rand	IR	$29.17	$31.34	$49.99	$40.82	1.65%
Gardner Denver	GDI	$74.24	$80.22	$84.10	$65.05	0.27%
Atlas Copco ADR	ATLCY	$16.18	$20.54	$23.40	$19.52	3.99%
United Technologies	UTX	$71.04	$77.87	$87.00	$75.61	2.70%
Donaldson	DCI	$61.93	$65.57	$59.26	$54.60	0.97%
SPX Corp.	SPW	$56.71	$54.99	$82.43	$66.16	1.76%

Atlas Copco Announces New Factory in China

Atlas Copco announced plans to begin construction of a new manufacturing facility for compressors in Wuxi, China, to meet the growing demand for compressors from the Chinese and other Asian markets.

The investment of approximately MSEK 150 includes the construction of a new compressor assembly factory, a test lab and a center for research and development. The new factory and the upgrade of existing facilities will allow for increased production of portable compressors, industrial and oil-free air compressors as well as compressor elements. "This investment will enable us to even better meet the needs of our local customers and thereby support the Group's profitable growth in the Asian market," says Stephan Kuhn, Business Area President of Atlas Copco Compressor Technique. " We will also be able to focus our innovative efforts on local development of energy-efficient products that meet upcoming more stringent efficiency requirements in China." Located about 10 kilometers from the current Atlas Copco Wuxi plant, in China's Jiangsu province, the new factory occupies a land surface of 45 000 square meters. The new production facility is planned to be operational in July 2012, serving both the Construction and Compressor Technique business areas. Atlas Copco currently has more than 5 000 employees in China, working at 13 manufacturing facilities and more than 100 offices around the country.

Gardner Denver Announces Record Results

Gardner Denver, Inc. (NYSE: GDI) announced third quarter results that established quarterly records for revenues, operating income, net income and DEPS.

Gardner Denver's third quarter 2011 revenues of $614.7 million were up 25% over the $493.4 million reported in the third quarter of 2010. Operating income

for the third quarter of 2011 was $106.6 million, a 57% increase from $68.0 million recorded in the same period of 2010. Operating margin improved 350 basis points to 17.3% in the third quarter of 2011. Net income in the third quarter of 2011 increased 58% to $73.6 million, or $1.42 per diluted share, from the third quarter 2010 level of $46.6 million, or $0.88 per diluted share. On a non-GAAP basis, excluding profit improvement costs and other items from DEPS as reflected on the reconciliation schedule below, third quarter adjusted 2011 DEPS ("Adjusted DEPS") were $1.48, a 68% increase over third quarter 2010.

In the third quarter of 2011, Gardner Denver repurchased 1.77 million shares of Gardner Denver stock at a total purchase price of $126 million. The buy-back was financed through a combination of cash on hand and the Company's existing credit facility. The repurchase increased DEPS by $0.02 in the third quarter of 2011.

CEO's Comments

"I am very pleased with the strong financial performance of the Company in the third quarter as our team's execution led to yet another quarter of record revenue and earnings," said Barry L. Pennypacker, Gardner Denver's President and Chief Executive Officer. "We continue to make progress on margin expansion, supported by the principles of the Gardner Denver Way, as evidenced by the Industrial Products Group achieving a 12.1% operating margin and delivering on its tenth consecutive quarter of sequential margin improvement. Cash flow was excellent, with operating cash flow totaling $97 million for the quarter," continued Mr. Pennypacker. "Our strong balance sheet and cash generation enabled us to opportunistically repurchase shares of Gardner Denver and pursue selective acquisitions such as the agreement to acquire Robuschi S.p.A. ('Robuschi'), announced on October 11, 2011. In addition, we invested $17 million in capital expenditures in the third quarter of 2011, with a sustained focus on operational improvements and increased capacity to meet growing customer demand."

Outlook

"While the global economy faces an uncertain future, we remain cautiously optimistic. Our backlog and order rates remain at healthy levels and we expect our businesses to grow in the fourth quarter of 2011, despite tougher comparisons to 2010. Our diverse portfolio of global businesses, supported by existing backlog, and proven operational capabilities will enable us to perform well," commented Mr. Pennypacker.

"This investment will enable us to even better meet the needs of our local customers and thereby support the Group's profitable growth in the Asian market."

— Stephan Kuhn, Business Area President of Atlas Copco Compressor Technique

WALL STREET WATCH

> "We continue to make progress on margin expansion, supported by the principles of the Gardner Denver Way, as evidenced by the Industrial Products Group achieving a 12.1% operating margin and delivering on its tenth consecutive quarter of sequential margin improvement."
>
> — Barry L. Pennypacker, Gardner Denver's President and Chief Executive Officer

"We anticipate fourth quarter 2011 DEPS to be approximately $1.42 to $1.47, and our full-year 2011 DEPS to be in the range of $5.24 to $5.29. These projections include profit improvement costs and other items totaling $0.03 per diluted share for the fourth quarter and $0.20 per diluted share for the full-year 2011. Fourth quarter 2011 Adjusted DEPS are expected to be in a range of $1.45 to $1.50. Full-year 2011 Adjusted DEPS are expected to be in a range of $5.44 to $5.49, an increase of 60% to 62% over Adjusted DEPS levels for 2010. The Robuschi acquisition is not expected to have a material impact on DEPS in the fourth quarter."

Engineered Products Group (EPG) EPG orders and revenues increased 7% and 38%, respectively, for the three months ended September 30, 2011, compared to the same period of 2010, reflecting strong demand for drilling and well servicing pumps, aftermarket products and related services, and growth in emerging markets. Operating margin(2) for EPG increased 360 basis points to 23.1% as compared to 19.5% in the third quarter of 2010. The improvement in operating income for this segment was primarily attributable to incremental profit on revenue growth, favorable product mix and cost reductions.

Industrial Products Group (IPG) Orders and revenues for IPG increased 21% and 14%, respectively, in the third quarter, compared to the same period of 2010, reflecting on-going improvement in demand for OEM products, custom engineered packages in Asia Pacific, and aftermarket parts and services. Operating margin for IPG increased 270 basis points to 12.1% as compared to 9.4% in the third quarter of 2010. The improvement in operating income for this segment was primarily attributable to incremental profit on revenue growth and cost reductions. BP

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JOB OPPORTUNITIES

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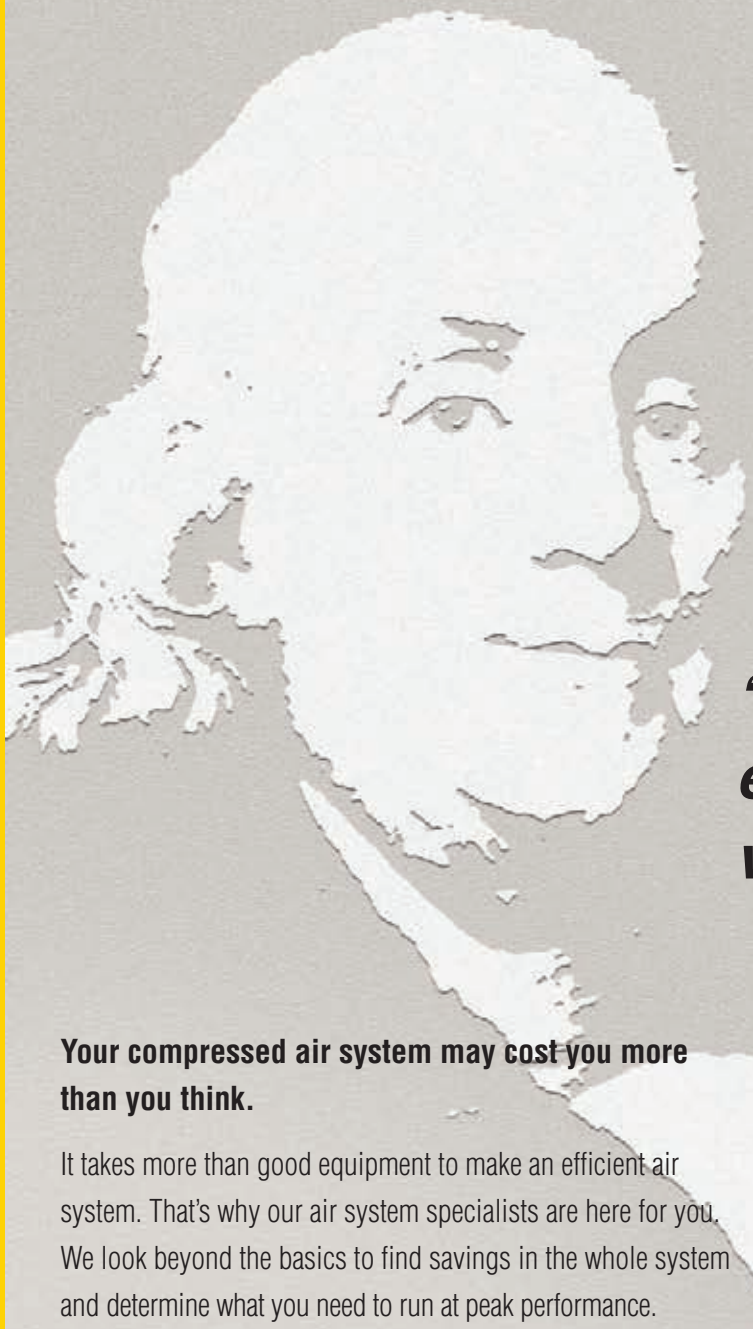

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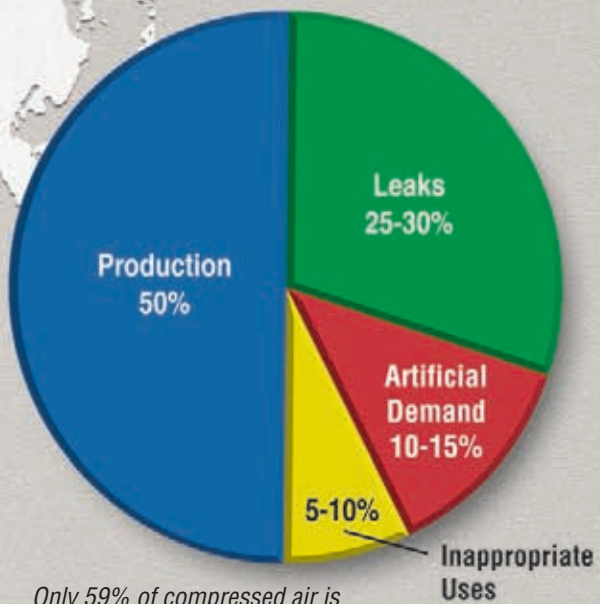

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